Untangling Disability and Poverty: A Matching Approach Using Large-scale Data in South Africa

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Abstract

Disability and poverty are interconnected with each other. This entangled relationship and the complexity of disability itself have hampered our understanding of poverty of persons with disabilities. This paper attempts to estimate the more accurate gap in multidimensional poverty between persons with and without disabilities in South Africa by removing the selection bias with a matching method and the large-scale household survey data. This paper also decomposes the gap in poverty between persons with and without disabilities with a matching-based decomposition method, in which it is mathematically shown that the decomposition method embraces the average treatment effect on the treated. The results reveal that persons with disabilities are more deprived in multidimensional poverty than matched persons without disabilities, particularly in terms of the breadth of poverty. The gap between them is larger for the subgroups of persons with difficulties in intellectual functionings, with multiple difficulties, adult males, Africans, Coloureds, and residents in rural areas. While a large part of the gap is attributable to disability for the younger group, the gap for the older group is explained not only by disability but also other factors, which indicates the existence of multiple discrimination in South Africa.

Keywords: Disability, Multidimensional poverty, South Africa, Matching, Decomposition analysis

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1. Introduction

Disability and poverty is no longer the agenda specific to the human rights perspective, but also from development perspectives. The United Nations Convention on the Rights of Persons with Disabilities ratified by more than 160 countries refers to the roles of international cooperation in improving the living conditions of persons with disabilities in developing countries. WHO and World Bank (2011) estimated the prevalence rate of persons with disabilities among the global population aged 15 years and over as 15.6-19.4%, corresponding to 785-975 million of people in 2010, and showed that the rate was higher in lower income countries. The 2030 Agenda for Sustainable Development adopted in September 2015 pays close attention to disability in the goals about education, employment, inequality, urban development and data collection, considering the cross-cutting nature of disability. Thus, the international development community is increasingly aware of the importance of reducing the poverty of persons with disabilities in this decade.

Under these circumstances, an empirical literature on disability and poverty has been expanding. For example, literature have explored effects on income or expenditure (Albert et al., 2015; Menon, Parish, and Rose, 2014; Takasaki, 2016), education (Lamichhane and Kawakatsu, 2015), employment (Rischewski et al., 2008; Mitra and Sambamoorthi, 2008; Mizunoya and Mitra, 2013), multiple indicators (Filmer, 2008; Mitra, Posarac, and Vick, 2013; Mont and Nguyen, 2011; Trani et al., 2015; Trani and Loeb, 2012), and child poverty (Trani, Biggeri, and Mauro, 2013; Trani and Cannings, 2013). On the whole, these studies found that disability was significantly associated with each indicator, though most of them did no more than simply compare persons with and without disabilities or examine the correlation between disability and each indicator with a few exceptions.[1]

Disability is considered to be complicatedly entangled with poverty as Groce et al. (2011: 1509) demonstrated "the need for more nuanced analysis that reflects the complex world within which poverty among persons with disabilities must be considered." This paper attempts to fill this research gap through three contributions to the literature. The first contribution is the more precise estimation of the gap in multidimensional poverty conditions between persons with and without disabilities. It has long been recognized that disability may be a cause and a consequence of poverty,

[1] Menon et al. (2014) coped with the endogeneity problem of disability by using an instrumental variable Wald estimator for the regression of disability status on the average monthly per capita expenditure at the district level in India. Takasaki (2016) considered landmine amputations in Cambodia as a disability caused by exogenous shock and evaluated the causal impacts of amputations on poverty by carefully selecting amputees due to landmine accidents and matching them with non-disabled adults within the same village.

that is, persons with disabilities are more likely to fall into poverty, whereas the poorer is also more likely to have disabilities (Elwan, 1999; Yeo and Moore, 2003). Since in many occasions persons with disabilities are already poor even before acquiring disability, simple comparison between persons with and without disabilities overestimates the genuine impact of disability, which is known as the selection bias. To deal with this bias, it is necessary to strictly control for the difference in the pre-existing poverty conditions. This paper employs one of the methods of impact evaluation, exact covariate matching, which compares a person with disabilities to those without disabilities who have the exactly same observable characteristics as the person with disabilities.[3] However, it should be noted that the results of exact covariate matching cannot be always interpreted as the causality because matching based on observable characteristics is not able to completely control for unobservable ones. By taking advantage of the large-scale data, this paper controls for observable characteristics as much as possible to minimize the selection bias, but the influences of unobservable factors might be unignorable. Therefore, the objective of this paper is to estimate the gap in multidimensional poverty conditions between persons with and without disabilities more accurately in compared to the existing studies, rather than to estimate the causal impacts of disability on poverty.

The second contribution is the disaggregation of analysis by compounding factors, which are personal and environmental factors other than disability such as type and severity of disabilities, age, gender, ethnic group, and location of residence. Some of the existing studies cited above analyzed in some subgroups, depending on each data composition and backgrounds of analyzed countries. As for the type of disability, persons with intellectual, mental or multiple disabilities are found to be more disadvantaged in terms of employment, multidimensional poverty, and child poverty (Mitra et al., 2013; Mizunoya and Mitra, 2013; Trani and Cannings, 2013; Trani et al., 2015; Trani and Loeb, 2012). Only a few studies conducted the analyses by severity of disability and found significant association of severe disability with schooling and child poverty (Lamichhane and Kawakatsu, 2015; Trani and Cannings, 2013). As for the gender difference, the results are mixed: girls and women are found to be more disadvantaged in some studies (Albert et al., 2015; Trani and Cannings, 2013; Trani et al., 2015; Trani and Loeb, 2012), whereas others found that men were more

[3] Similarly, Rischewski et al. (2008), Trani et al. (2015), and Trani and Loeb (2012) matched persons with and without disabilities based on age, gender, and location of residence. They conducted a case-control random survey in which they firstly sampled persons with disabilities and then, for each person with disabilities, found and interviewed those without disabilities who are the same years old, the same gender, and live in the same area as the person with disabilities. While these studies controlled for other factors in advance, this paper does ex post using a secondary household data.

disadvantaged (Menon et al., 2014; Mitra et al., 2013; Mizunoya and Mitra, 2013; Mont and Nguyen, 2011). As for the regional difference, almost all studies found that persons with disabilities in the rural area face more disadvantages in compared to the urban area. One of the major obstacles for these subgroup analyses of disability and poverty is the small number of observations of persons with disabilities in the dataset. It is often the case that the number of persons with disabilities is limited to a few hundreds at most. Even if dividing this into subgroups, the number of observations of each subgroup is too small to conduct the reliable analysis. This might explain in part the mixed results about gender difference, and the scarcity of analyses by severity of disability. The data used in this paper is much larger than that of the existing studies, which enables a more reliable analysis by several compounding factors.

The third contribution is the use of decomposition analysis for the gap in multidimensional poverty conditions between persons with and without disabilities. The decomposition analysis, represented by the Blinder-Oaxaca decomposition, has been used to divide the gap in an outcome between two groups, e.g., the gender wage gap, into a part explained by the difference in observable factors of two groups except for group status and a part not explained by the difference in observable factors under the conditional independence and overlap assumptions (Fortin, Lemieux, and Firpo, 2011). Then, the latter part is interpreted as the effect of difference in social status of the groups. Fortin et al. (2011) argued that the former and latter parts correspond to the selection bias and the treatment effects in the literature of impact evaluation, respectively. While impact evaluation methods usually focus only on the latter, it is the major interest of the decomposition analysis to examine how much each part accounts for the total gap. Since the poor is considered to be more likely to acquire disability as discussed above, estimating not only the effects of disability on poverty, but also the selection bias through the decomposition analysis leads to more comprehensive understanding about disability and poverty. More specifically, this paper applies a matching-based decomposition method developed by Ñopo (2008) in which exact covariate matching is used. In the subsequent section on the statistical model of this decomposition method, I mathematically prove that the part not explained by the difference in observable factors is identical to the effects of disability estimated by exact covariate matching. To the best of my knowledge, this is the first study to conduct the decomposition analysis for disability and poverty and explicitly relate the methods of impact evaluation and decomposition analysis.[4]

[4] The decomposition analyses for the wage gap between persons with and without disabilities already exist, for example, the studies by Longhi, Nicoletti, and Platt (2012) in the United Kingdom and by

The remainder of this paper is organized as follows: Section 2 explains the conceptual framework of disability and poverty and the context of disability in South Africa. Section 3 introduces the data used in this paper and briefly describes the characteristics of sample for the analysis. Section 4 explains the empirical methods adopted in this paper and Section 5 shows the empirical results. Section 6 concludes with the implications of the findings.

2. Backgrounds

2.1 Conceptual framework of disability and poverty

Disability and poverty are conceptually close to each other. Similar to the issue of poverty, disability is considered to be "complex, dynamic, multidimensional, and contested" (WHO and World Bank, 2011: 3). As poverty does not simply mean the low level of income or consumption today, disability no longer simply means the loss of body structure or limitation of body function, i.e., impairment, since the social model of disability prevailed. The social model of disability argues that disability does not belong to only persons with impairments, but to social environment that restricts their opportunities to participate in society through physical, institutional, and attitudinal barriers (Barnes, Mercer, and Shakespeare, 1999; Oliver, 1996). In the view of the social model of disability, disability emerges in the interaction between persons with impairments and environmental factors, and thus, disability is defined as the loss or limitation of participation in society and the resulting disadvantages imposed on persons with impairments. As another approach for the definition, disability is conceptualized from the perspective of the capability approach which has an affinity with the social model of disability (Burchardt, 2004; Mitra, 2006; Trani et al., 2011). Sen (1999) regarded impairment as one of personal characteristics and sometimes cited persons with impairments as the instance of the diversity of human beings in his explanation of the capability approach. In common with other personal characteristics, impairment interacts with other personal characteristics, available resources, and economic, social and cultural factors and affects the capability of persons with impairments. Mitra (2006, 241) stated that "(a)n impairment is a prerequisite to disability, but it is only one of the factors, along with the person's other characteristics (e.g., age, gender, race), the resources available, and the environment, that lead to capability or functioning deprivation—in other words, to disability." Since poverty is also defined as the deprivation of basic capabilities in the capability approach, it can be said that disability is conceptually adjacent to poverty in the sense of the capability approach. Furthermore,

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Baldwin and Choe (2014) in the United States.

applying the capability approach to disability requires us to control for personal and environmental factors in order to precisely assess the effect of disability on poverty, and to disaggregate the analysis into subgroups categorized by these factors.

Disability and poverty are not only conceptually associated with each other, but also interconnected in such a way that one is a cause and consequence of the other. Yeo and Moore (2003) explain the two-way causality behind disability and poverty as follows: persons with impairments confront with social barriers in the form of environmental, institutional and attitudinal discrimination and are excluded from education system, labor market, community activities, basic health care, and access to limited resource such as food and clean water. Their income generating opportunities are restricted due to low skills and poor health, and fall into income poverty and further chronic poverty. Moreover, insufficient public support for treatment or rehabilitation costs is directly connected to income poverty. On the other hand, chronic poverty leads to limited access to education and health care, insufficient food, and poor sanitation, and results in being forced to work at unsafe workplaces and live under unhygienic conditions with malnutrition and poor health, which increases the risk of acquiring impairments and chronic illness. In this way, persons with disabilities are more likely to fall into poverty, and at the same time, the poorer is more likely to receive impairments in their lives and be forced to face disabilities. The latter direction of causality matters when evaluating rigorously the impact of disability on poverty because persons with disabilities might be already poorer than those without disabilities even before receiving impairments.

2.2 Context of disability in South Africa

South Africa has been paying higher attention to disability in compared to other developing countries. The disability rights movement had been led by disabled activists and domestic disabled people's organizations since 1980s in connected with the anti-apartheid movement (Howell, Chalklen, and Alberts, 2006). As a result, the current constitution adopted after the democratization in 1994 stipulates the prohibition of discrimination based on disability as well as race, gender, and so on. The government ratified the United Nations Convention on the Rights of Persons with Disabilities in 2007 and promoted the preparation of laws and institutions related to disability in the area of education, employment, and social securities. However, the disability policies in South Africa has been exposed to criticism about the implementation from the public, and the effectiveness on the lives of persons with disabilities has been questioned (Dube, 2005). For example, Human Rights Watch (2015) reported the discriminatory decisions by schools about the enrollment of children with disabilities, the lack of accommodation

for school facilities, and low-quality teaching to children with disabilities. In addition, the government settled the official goal for the employment rate of persons with disabilities in the public sector at 2% by 2005, though the goal has been not achieved and the average employment rate by the public sector was 0.39% in the fiscal year of 2012 (Government of South Africa, 2015). Gooding and Marriot (2009) demonstrated the problems in the disability grant program in South Africa such as complex and unaccountable systems leading to misunderstanding of the criteria, incorrect payment, and delay of procedure, and physical inaccessibility to receive the grant. In the systematic review of Banks et al. (2017) on disability-related social protection programs in low- and middle-income countries, several papers verified the exclusion of persons with disabilities from the disability grant and care dependency grant programs and their limited effects on poverty reduction in South Africa.

According to the population census in 2011, the share of persons with disabilities is 7.5% of the whole population aged above five years, corresponding to about 2.9 million people, and they are found to be disadvantaged in education, employment, income, and so on (Statistics South Africa, 2014). The conditions of lives of persons with disabilities in South Africa have been so far reported based on several national surveys and case studies in some regions (DSD, DWCPD and UNICEF, 2012; Graham et al., 2014; Graham and Ross, 2016; Loeb et al., 2008; Moodley and Ross, 2015). However, these studies mainly depend on the descriptive, qualitative, or brief quantitative analysis, and thus the aforementioned analytical challenges, two-way causality between disability and poverty and the disaggregation of analysis, have not been tackled yet in the study in South Africa. In particular, as the influence of racial discrimination in the past seem to still remain prominent in South Africa, it is necessary to examine how disability and race are related to each other when considering the poverty of persons with disabilities. In addition, Moodley and Graham (2015) and Maart et al. (2007) emphasized the need for further investigation in gender and regional differences in the lives of persons with disabilities in South Africa.

3. Data and descriptive analysis

This paper uses the 10% sample data of South African census in 2011 (Statistics South Africa, 2015a). The sample size is 4,337,697 individuals within 1,194,122 households. The census asked about the functional difficulties, based on the short set of questions developed by the United Nations Washington group on Disability Statistics. It covered six domains of functioning: seeing, hearing, communication, walking or climbing stairs, remembering or concentrating, and self-care such as washing, dressing, and feeding. Respondents were asked to answer each condition of all household members aged

above five years from the four choices, "no difficulty," "some difficulty," "a lot difficulty," and "cannot do at all" in principle.[5] Before conducting the census, Statistics South Africa confirmed the validity of these questions and the correctness of their words in the context of South Africa through focus group discussion and pilot surveys (Schneider, 2009; Schneider et al. 2009). As for the response of "some difficulty," Miller et al. (2010) casted doubt on the reliability of self-report about minor health problems, and for that reason Mitra et al. (2013) and Mizunoya and Mitra (2013) used the difficulties severer than "a lot difficulty" for the definition of disability group. This paper follows this definition for each functioning and hereafter calls the difficulty level of "a lot difficulty" and "cannot do at all" as moderate and severe difficulty, respectively. Persons without disabilities are also narrowly defined as those who do not have any difficulties for all six functionings. Those with "some difficulty" in any functionings at the most were dropped to remove the possibility of false positives, i.e., measurement error about having difficulties. Thus, the sample for the analysis consists of persons with a moderate or severe difficulty in at least a functioning and those without any difficulties for all six functionings.

The sample for analysis in this paper is persons aged 6 to 64 by taking into accounts the ages of starting to attend primary school (5-6), compulsory education (7-15) and the working-ages (15-64) in South Africa. Then, children aged 6 to 14 who answered that they had difficulties in self-care were excluded because Statistics South Africa (2014) explicitly referred to the possibility of misunderstanding by the respondent of the census on the question of self-care. They may have answered having difficulties in self-care due to the age of children, and not due to impairments, which was the intention of the questionnaire.[6] To deal with this potential measurement error, children were dropped if they have a difficulty only in self-care. The resulting sample size for the analysis is 2,748,999, which includes 90,867 persons with moderate or severe difficulties in any functionings, 3.3% of the total. This is lower than the aforementioned ratio of Statistics South Africa (2014), 7.5%, because they adopted a wider definition of disability group that is a "some difficulty" in more than two functionings or a difficulty severer than "a lot difficulty" in at least a functioning.

Figure 1 illustrates each age distribution of persons with and without disabilities by gender. The age distribution of those without disabilities (hatched bars) forms the

[5] The survey asked the difficulty in seeing or hearing when using an assistive device such as eyeglasses or a hearing aid. Household heads could refuse against this question or answer as "do not know" or "cannot yet be determined." The rate of these invalid answers in the data is about 8% for all domains of functionings expect for self-care whose invalid rate is 15%.

[6] Before excluding, 22,696 persons aged 6 to 64 reported a moderate or severe difficulty in self-care and 82.8% of them are children aged 6 to 14. This was extremely biased in compared to other functionings.

shape of pyramid, i.e., a relatively large share of the youth and decreasing share of older people, as often observed in other countries. In contrast, as for the age distribution of those with disabilities (closed bars), the prevalence of people in the mid-forties or older is high for both males and females, showing that the probability to receive impairments increases as people ages. The reason why the frequency of children aged 6 to 8 is relatively high for those with disabilities is because many children aged those years were reported to have the difficulty in communication. This may be attributable to the misreporting about the difficulty related to being too young, but these observations were kept for the analysis because to my knowledge there are no reports or arguments mentioning to the possibility of misreporting.

Table 1 shows the share of persons with disabilities by type and severity of functional difficulties in each age group of 6-14, 15-24, 25-39, 40-54, and 55-64. The difficulties in seeing and remembering account for the large share for all age groups. The share of communication is high among children aged 6-14, that of self-care is high for 15-24 aged group, and that of walking is high for the other older groups. The share of persons with moderate difficulties in seeing and walking is higher in the older groups, which is considered as the influences of aging. In addition to six types of disabilities, this paper takes into account persons who have difficulties in multiple functionings. Their share is about 20% for all age groups as shown at the bottom of the table.

Table 2 compares persons with disabilities and without disabilities in gender, race, and residence area by age groups. As for gender, the ratio of males is higher than females in both 6-14 aged persons with and without disabilities, whereas the former group incorporates relatively more males than the latter group (the first and second columns). In contrast, persons with disabilities incorporate relatively more females for the older groups except for 15-24 age group (the fifth to tenth columns). These might be explained in part by the lag in the growth of boys relative to girls and by the influences of gender discrimination for women. As for race, the ratio of Africans is higher in persons with disabilities than those without disabilities for all age groups, meaning that Africans are more representative for the former group. It is also remarkable that Whites is less representative in persons with disabilities for all age groups. As for the area of residence, the rural area in South Africa is divided into the rural formal and tribal (or traditional) areas. The tribal area is defined as the area legally administered by tribal authorities and almost all of residents are Africans. Table 2 shows that the residents in the tribal area are more representative in persons with disabilities. Putting these results together, it can be said that those expected to face the existing disadvantages is more likely to have disabilities in South Africa.

As illustrated so far, persons with disabilities are apparently different from

those without disabilities in personal and environmental characteristics, and there seem to be selection from the more disadvantaged population to the disability group. In addition, there is variation in type and severity of disability even within persons with disabilities. These findings underline the need to deal with the possible selection bias in the analysis of disability and poverty, and to conduct the subgroup analyses.

4. Empirical methods

4.1 Model

The empirical analysis in this paper utilizes the empirical methods from two strands of literature, impact evaluation and decomposition analysis. As explained in the Introduction section, exact covariate matching and Ñopo (2008)'s matching-based decomposition are employed among others to control for and quantify the influences of the pre-existing poverty conditions of persons with disabilities, that is, the selection bias. Although propensity score matching has been more frequently used in the literature of impact evaluation than exact covariate matching, I chose the latter mainly because, by using it, the relationship between impact evaluation and decomposition methods can be clearly specified as shown below. This sub-section shows the model of the matching-based decomposition developed by Ñopo (2008) and then proves that the part not explained by observable factors in the decomposition model corresponds to the average treatment effect on the treated estimated by exact covariate matching.

Ñopo (2008)'s matching-based decomposition method has the advantages over the conventional Blinder-Oaxaca decomposition in consideration of the difference in the supports of the distribution of observable factors for two groups of interest and nonparametric estimation of each decomposed part. Specifically, he considered all samples including both of those in and out of common support and decomposed the gap into four parts: one part due to group status, another part due to observable factors other than group status, and the other two parts due to characteristics specific to each group.

Let Y and X denote the poverty conditions and the vector of observable characteristics of individuals, respectively, by following the notation of Ñopo (2008). The disability and non-disability groups are denoted by as W_1 and W_0, the conditional cumulative distribution function for each group by as $F_1(X)$ and $F_0(X)$, and the set of actually observed characteristics for each group by as S_1 and S_0. By introducing the functions of expected value of poverty conditional on disability status and other characteristics as $E[Y|W_1, X] = g_1(X)$ and $E[Y|W_0, X] = g_0(X)$, the expected value of poverty of persons with and without disabilities can be written as $E[Y|W_1] = \int_{S_1} g_1(X)dF_1(X)$ and $E[Y|W_0] = \int_{S_0} g_0(X)dF_0(X)$. Then, the difference in poverty

conditions between these two groups, $\Delta = E[Y|W_1] - E[Y|W_0]$, can be expanded by dividing each integral into two parts, the part evaluated at the common support, $C = S_1 \cap S_0$, and the part evaluated out of the common support:

$$\begin{aligned}\Delta &= \int_{S_1} g_1(X)dF_1(X) - \int_{S_0} g_0(X)dF_0(X) \\ &= \int_C g_1(X)dF_1(X) + \int_{\bar{C}} g_1(X)dF_1(X) \\ &\quad - \left[\int_C g_0(X)dF_0(X) + \int_{\bar{C}} g_0(X)dF_0(X)\right]\end{aligned}$$

By defining the share of persons located in the domain S as $\mu_1(S) = \int_S dF_1(X)$ and $\mu_0(S) = \int_S dF_0(X)$, the cumulative distribution function of each integral is rescaled by using the shares of persons in and out of the common support,

$$\begin{aligned}\Delta &= \left[\int_C g_1(X)\frac{dF_1(X)}{\mu_1(C)}\right]\mu_1(C) + \left[\int_{\bar{C}} g_1(X)\frac{dF_1(X)}{\mu_1(\bar{C})}\right]\mu_1(\bar{C}) \\ &\quad - \left[\int_C g_0(X)\frac{dF_0(X)}{\mu_0(C)}\right]\mu_0(C) - \left[\int_{\bar{C}} g_0(X)\frac{dF_0(X)}{\mu_0(\bar{C})}\right]\mu_0(\bar{C})\end{aligned}$$

Then, replacing $\mu_1(C)$ with $1-\mu_1(\bar{C})$ and $\mu_0(C)$ with $1-\mu_0(\bar{C})$, the decomposition equation develops as follows,

$$\begin{aligned}\Delta &= \int_C g_1(X)\frac{dF_1(X)}{\mu_1(C)} - \int_C g_0(X)\frac{dF_0(X)}{\mu_0(C)} \\ &\quad + \left[\int_{\bar{C}} g_1(X)\frac{dF_1(X)}{\mu_1(\bar{C})} - \int_C g_1(X)\frac{dF_1(X)}{\mu_1(C)}\right]\mu_1(\bar{C}) \\ &\quad + \left[\int_C g_0(X)\frac{dF_0(X)}{\mu_0(C)} - \int_{\bar{C}} g_0(X)\frac{dF_0(X)}{\mu_0(\bar{C})}\right]\mu_0(\bar{C})\end{aligned}$$

Lastly, by adding and subtracting the counterfactual of poverty conditions, $\int_C g_0(X)\frac{dF_1(X)}{\mu_1(C)}$, which means the hypothetical poverty conditions of persons with disabilities if they had not have disabilities, the decomposition equation can be expressed in the following way,

$$\begin{aligned}\Delta &= \int_C [g_1(X) - g_0(X)]\frac{dF_1(X)}{\mu_1(C)} + \int_C g_0(X)\left[\frac{dF_1}{\mu_1(C)} - \frac{dF_0}{\mu_0(C)}\right](X) \\ &\quad + \left[\int_{\bar{C}} g_1(X)\frac{dF_1(X)}{\mu_1(\bar{C})} - \int_C g_1(X)\frac{dF_1(X)}{\mu_1(C)}\right]\mu_1(\bar{C}) \\ &\quad + \left[\int_C g_0(X)\frac{dF_0(X)}{\mu_0(C)} - \int_{\bar{C}} g_0(X)\frac{dF_0(X)}{\mu_0(\bar{C})}\right]\mu_0(\bar{C})\end{aligned}$$

which is expressed by following the notation of Ñopo (2008) as

$$\Delta = \Delta_0 + \Delta_X + \Delta_w + \Delta_{w/o}$$

The first two terms are associated with the differences between the subgroups of disability and non-disability groups which share the observable characteristics, or in other words, the subgroups of individuals successfully matched with the counterpart. The first term, Δ_0, is the difference in poverty conditions between persons with and without disabilities where the distribution of observable characteristics is the same, which corresponds to $\overline{X_1}(\widehat{\beta_1} - \widehat{\beta_0})$ in the Blinder-Oaxaca decomposition. The second term, Δ_X, is the part of the gap deriving from the difference in the distribution of characteristics between persons with and without disabilities over the common support, which corresponds to $(\overline{X_1} - \overline{X_0})\widehat{\beta_0}$ in the Blinder-Oaxaca decomposition. The other two terms are added by Ñopo (2008) to the Blinder-Oaxaca decomposition, taking into account the difference in characteristics between matched and unmatched individuals within each group. The third term, Δ_w, is related to the influences of the characteristics specific to persons with disabilities that those without disabilities does not have, and the forth term, $\Delta_{w/o}$, is related to the influences of the characteristics specific to those without disabilities that those with disabilities does not possess. According to Ñopo (2008), the Blinder-Oaxaca decomposition is still appropriate if it restricts the comparison of two groups in the common support. Otherwise, it overestimates Δ_0 due to implicitly assuming that the outcome function estimated based on the observed characteristics of a group is also valid at the out-of-support of the group.

Each term is estimated with the weighted averages of poverty conditions and the share of persons with and without disabilities out of the common support. Thus, it is not necessary to specify the functional forms of conditional poverty conditions, $g_1(X)$ and $g_0(X)$, and estimate them, which is another advantage of the matching-based decomposition. Specifically, Δ_0 is estimated by taking the difference of the weighted average of poverty conditions between persons with and without disabilities evaluated at all combination of covariates of persons with disabilities. Suppose that the number of covariates under consideration is *L*, and that *K* combinations of values a person can take, $\{x_1, \dots, x_k, \dots, x_K\}$, are constructed from the L covariates, where x_k is a $L \times 1$ vector. Define N_{1k} and N_{0k} as the number of persons with and without disabilities who take the *k*-th combination of covariates $X_i = x_k$, and let $\delta_k = 1[N_{1k} > 0,\ N_{0k} > 0]$, which indicates whether or not the *k*-th combination of covariates is located in the common support. Lastly, define $\overline{Y_1^k}$ and $\overline{Y_0^k}$ as the average poverty conditions of persons with and without disabilities who take $X_i = x_k$. Then, Δ_0 can be estimated as follows:

$$\widehat{\Delta_0} = \frac{\sum_k \delta_k N_{1k} \left(\overline{Y_1^k} - \overline{Y_0^k}\right)}{\sum_k \delta_k N_{1k}}$$

where $\delta_k N_{1k}$ plays the role as weight when calculating the weighted average. Then, the term in the numerator is developed as

$$\widehat{\Delta_0} = \frac{\sum_k \delta_k \{\sum_{i\in\{i|X_i=x_k\}} Y_{1i} - N_{1k}\overline{Y_0^k}\}}{\sum_k \delta_k N_{1k}}$$

The term in parenthesis in the numerator can be further divided into N_{1k} terms which take the difference between the poverty conditions of a person with disabilities with $X_i = x_k$ and $\overline{Y_0^k}$. Therefore, each person with disabilities is compared with the average of multiple persons without disabilities who have the exactly same characteristics as him/herself, which is called as one-to-many matching and the reason of the name of matching-based decomposition. Similarly, the other three terms can be also estimated as the difference of weighted averages of poverty conditions. As for the estimation of standard errors of all parts, I adopted the bootstrap method based on 100 replicates.

While Ñopo (2008) conducted exact covariate matching to classify which individuals of two groups are located in or out of the common support, he did not relate his method with the method of impact evaluation. I show below that Ñopo's Δ_0 and the average treatment effect on the treated are actually the same, using the model of exact covariate matching introduced by Angrist (1998). First of all, two potential poverty conditions, Y_1 and Y_0, are defined as one when a person has an impairment and when a person does not, respectively. The actually observed poverty for each person is $Y = Y_1W_1 + Y_0W_0$, where W_1 and W_0 denote the disability and non-disability groups as defined above. Under this definition, the difference in average values of poverty conditions between persons with and without disabilities is

$$\begin{aligned} E[Y|W_1] - E[Y|W_0] &= E[Y_1|W_1] - E[Y_0|W_0] \\ &= E[Y_1 - Y_0|W_1] + \{E[Y_0|W_1] - E[Y_0|W_0]\} \end{aligned}$$

The first term is called the average treatment effect on the treated (hereafter, ATT), and one of the estimators of interest in the literature. The second term is called the selection bias, meaning the difference in the potential conditions between two groups. If people randomly acquire a disability, this term is equal to zero and ATT can be estimated by simply taking the difference of average of poverty conditions of two groups. However, it seems to be not the case as discussed above and confirmed by the descriptive analysis in the previous section. For the estimation of ATT, exact covariate matching depends on the conditional independence assumption of Rosenbaum and Rubin (1983) that disability status is independent of potential poverty conditions conditional on observable characteristics, which can be expressed as $(Y_1, Y_0) \perp\!\!\!\perp (W_1, W_0)|X$, where X is a vector of pre-determined covariates. By iterating $E[Y_1 - Y_0|W_1]$ over X,

$$\begin{aligned} \Delta_{ATT} &= E[Y_1 - Y_0|W_1] = E\{E[Y_1 - Y_0|W_1, X]|W_1\} \\ &= E\{E[Y_1|W_1, X] - E[Y_0|W_1, X]|W_1\} \end{aligned}$$

Since the second term is equal to $E[Y_0|X, W_0]$ under the conditional independence assumption,

$$\Delta_{ATT} = E\{E[Y_1|W_1, X] - E[Y_0|W_0, X]|W_1\}$$
$$= \int \{E[Y_1|W_1, X] - E[Y_0|W_0, X]\} dF_1^*(X)$$

where $dF_1^*(X)$ is the conditional cumulative distribution function of persons with disabilities over the common support. It is assumed behind the final equation that the distributions of covariates of persons with and without disabilities sufficiently overlap, or in other words, that we can find a sufficient number of persons without disabilities who take the same values of covariates as those with disabilities. This is called common support or overlap assumption which is expressed as $0 < \Pr(W_1|X) < 1$. Lastly, by the definition above,

$$\Delta_{ATT} = \int_C [g_1(X) - g_0(X)]\, dF_1^*(X)$$

which is identical to Δ_0 in the matching-based decomposition model.

4.2 Procedure of exact covariate matching

Matching of persons with and without disabilities was conducted based on different sets of covariates for children aged 6-14 and adults aged 15-64. I chose the covariates for matching from the dataset as those that are predetermined, fundamental characteristics, and considered to be associated with poverty. Children with disabilities were matched with those without disabilities who have the exactly same characteristics in respect of 10 variables: age, gender, population group, main language in the household, municipality of residence, type of residence area, municipality of residence in 2001, province of birth place, absence of father in the household, and education level of parents. Similarly, adults with disabilities were matched with those without disabilities sharing the exactly same characteristics in respect of nine variables: age, gender, population group, main language in the household, municipality of residence, type of residence area, municipality of residence in 2001, province of birth place, and position in a household (a household head or not). As for the main language, there are 13 choices in the dataset such as Zulu, Xhosa, Afrikaans, and so on. The municipalities in the dataset consist of eight metropolitan municipalities and 226 local municipalities, and each municipality can be further divided into three types of area (urban, rural formal and/or tribal areas). The purpose of including municipalities of residence in 2001, the year of the previous census, and province of birth place is to control for the experience of domestic migration in the recent and distant past. I assumed that children born after 2001 had lived in 2001 in the same municipality as that in 2011. The reason of using

province level but not municipality level for birth place is just because the information of municipality of birth was excluded from the public dataset for the privacy policy. The father absence in the household is used for matching because it has been discussed as one of the issues about family in South Africa and considered to have the negative influences on the lives of children economically and emotionally (Richter, Chikovore, and Makusha, 2010; Richter and Morrell, 2006). In fact, about 70% of children in the original 10% sample of the 2011 census do not have fathers within the same household due to living apart or death. The education level of parents is measured by seven levels: no schooling, dropped out at primary school, completed primary school, dropped out at secondary school, completed secondary school, higher than secondary school, and other education. Since mothers play a primary role as a care-giver of children, especially in South Africa due to father absence, and their education level is considered important for the wellbeing of children in the literature, I used the education level of mothers for matching at first, and used that of fathers if the information of a mother is not available. If both information of a father and a mother is missing. I used that of the household head.

As explained in the previous sub-section, one-to-many matching was conducted: when finding more than two counterparts who have the same characteristics as a person with disabilities to be matched, the average value of those counterparts was compared with that of the person with disabilities. As a result, 82.26% of children with disabilities were successfully matched with those without disabilities and so were 82.28% of adults with disabilities. These matching rates seem to be adequately high by virtue of the large-scale data, taking into consideration that the matching rate between males and females based on four covariates was at most 60% in the application example of Ñopo (2008). In the following section, the gap in poverty between persons with and without disabilities is examined after matching, i.e., using only the sample in the common support. The sample in the out-of common support is used in the decomposition analysis to comprehensively investigate the observed gap between persons with and without disabilities.

4.3 Multidimensional poverty measures

In order to broadly compare the poverty conditions of persons with and without disabilities, this paper adopts the multidimensional poverty measures developed by Alkire and Foster (2011). Their method of estimation for multidimensional poverty has been utilized for the calculation of Multidimensional Poverty Index (MPI) in the Human Development Report of United Nations Development Programme since 2010 (Alkire and Santos, 2014). Although the dimensions and individual poverty indicators adopted

by this paper is not identical to those of MPI due to the availability of variables in the dataset, I follow the procedure to calculate the multidimensional poverty measures summarized by Alkire and Foster (2011).

Their procedure begins with the choice of dimensions, the set of indicators in each dimension, the deprivation cutoff for each indicator to judge whether or not a person is deprived in that indicator, and the relative weight for each indicator to compute the weighted average of deprivation, called the deprivation score. I prepared 10 indicators in three dimensions for children and 11 indicators in four dimensions for adults as shown by Table 3. These dimensions and indicators were selected by basically following Alkire and Santos (2014), Mitra et al. (2013), and Trani et al. (2015), and the availability of variables in the dataset. Among others, I adopted the labor market participation as an indicator for employment instead of unemployment used in the previous studies. Since South Africa has been long confronting high unemployment rate, persons with disabilities are considered to give up working even at the phase of searching for a job. While the disability grant program in South Africa may reduce the motivation of persons with disabilities to participate in the labor market, this indicator can be used to capture the deprivation in social participation. However, a person is defined as not deprived in this indicator if the reason for not searching for a job is health reasons such as heavy impairments and pregnancy, including other reasons such as student, trainee, housewife, retirement, and so on. As for household income per capita, each household member's total income from all sources including disability grant was summed up and divided by the number of household members. In addition, I adopted the usage of internet as the indicator of access to information because the role of information and the problem of digital divide seem to increasingly have the importance for the poverty issues in developing countries, particularly in the middle-income countries such as South Africa where the infrastructure for information and communication technology has be being developed. The deprivation cutoff for each indication was determined, depending on the previous studies constructing the MPI in South Africa (Finn, Leibbrandt, and Woolard, 2013; Oxford Poverty and Human Development Initiative, 2011; Rogan, 2016). The weight for each indicator was set in the same way as Alkire and Santos (2014) and Mitra et al. (2013) in which equal weight is given to each dimension, e.g., one third in the case of children, and then the weight is equally divided into each indicator, e.g., one sixth for the indicators of assets and monthly household income per capita for children.

Using the condition of deprivation in the j-th indicator for the i-th person, c_{ij}, and the relative weight for each indicator, w_j, the deprivation score for the i-th person is calculated as $c_i = \sum_{j=1}^{d} w_j c_{ij}$, where d is the number of indicators. Then, a person is

determined to be multidimensionally poor if his/her derivation score exceeds the poverty cutoff, k:

$$q_i = \begin{cases} 1 & \text{if } c_i \geq k \\ 0 & \text{if } c_i < k \end{cases}$$

I fixed k at 0.4 in common with Mitra et al. (2013) and Trani et al. (2015). Thus, the first main measure of multidimensional poverty, the headcount ratio of the multidimensionally poor, can be computed as $H = \sum q_i / N$. The second measure of multidimensional poverty is the average deprivation share calculated as $A = \sum q_i \, c_i / \sum q_i$, which corresponds to the average value of the deprivation score among the multidimensionally poor. While the headcount ratio is said to reflect the incidence or breadth of multidimensional poverty, the average deprivation share means the intensity or depth of multidimensional poverty. The last but the most important measure of multidimensional poverty, the adjusted headcount ratio, is calculated as $M_0 = H \times A = \sum q_i \, c_i / N$, which represent both breadth and depth aspects of multidimensional poverty.

5. Empirical results

5.1 Results of exact covariate matching

Table 4 compares the multidimensional poverty measures of persons with and without disabilities before and after matching by age group. Before matching, all multidimensional poverty measures are higher in the disability group than in the non-disability group for all age categories (the third columns), and the gap between two groups remains even after equalizing persons with and without disabilities in terms of other factors (the sixth columns). The t-tests were conducted for the mean of difference in each multidimensional poverty measure between disability and non-disability groups before and after matching. As a result, all of the gaps were statistically significant at 1% level. Since this seems to be mainly attributable to the statistical power enhanced by the large sample size, this paper does not put much emphasis on the statistical significance of the results reported in Table 4 and other tables. In compared to the headcount ratio, the gap in average deprivation share is smaller even before matching so that it does not change much after matching, which implies that the deprivation experienced by the poor is not affected by disability status and other controlled factors in the case of South Africa. The relatively smaller gap in average deprivation share between disability and non-disability groups was detected also in the case of Tunisia (Trani et al., 2015), and Mitra et al. (2013) found that the number of countries with significant gap in average deprivation share is smaller than those with significant gap in headcount ratio. Consequently, the gap in adjusted headcount ratio is mostly caused by the gap in headcount ratio. In other words, disability aggravates the conditions of

multidimensional poverty in light of breadth rather than depth.

The adjusted headcount ratio after matching is the highest for the oldest group and the lowest for the youngest group both within disability and non-disability groups (the fourth and fifth columns), whereas the gap between these groups is slightly larger for the age groups of 25-39 and 40-54, i.e., the core working-age groups, and almost same for the youngest and oldest groups (the sixth column). When comparing the relative size of the gap in adjusted headcount ratio, it is the largest for 25-39 age group (0.070/0.144=48.8%), followed by the youngest group (0.042/0.105=40.0%), and the lowest for the oldest group (0.045/0.325=13.7%).

Examining the headcount ratio before and after matching, the ratio of disability group slightly increases after matching for all age groups (the first and forth columns), and that of non-disability group also increases, but relatively more sharply (the second and fifth columns), which leads to the narrowed gap after matching (the third and sixth columns). This is also true of the gap in the adjusted headcount ratio because the gap in the average deprivation share does not change through matching. The fact that the headcount ratio of matched persons without disabilities is higher than the original ratio implies that those without disabilities sharing the observable characteristics with those with disabilities are more likely to be multidimensionally poor, and thus indicates the other way of causality from poverty to disability, i.e., that the poor is more likely to receive an impairment. Therefore, the narrowed gap after matching suggests that matching is controlling, at least partially, for this reversed causality.

In order to investigate the difference in the influences of disability more closely, Table 5 compared persons with and without disabilities after matching in each age group by indicator for the multidimensional poverty measures. For children with disabilities, as expected, the gap in the deprivation in the school attendance is the largest among other indicators. The ratio of children with disabilities not attending school is more than twice as high as that of those without disabilities (the first and second columns), which results in the large gap in the adjusted headcount ratio between children with and without disabilities. The gaps in the other indicators of the household level are not large in compared to school attendance, but the positive gaps consistently exist in all indicators (the third column). The covariates about parental characteristics used for the matching in this paper might not be able to completely remove the influences of household income on having children with disabilities. However, the gaps in household level indicators seem to imply that children with disabilities might have the household-level influences through increasing medical expenditures and decreasing time for parents to work due to the care for them.

For adults with disabilities, the gaps in the indicators of the individual level,

years of schooling and labor market status, are larger than in those of the household level in common with children. The ratio of the deprivation in years of schooling is lower in the younger group, e.g., 16.2% for 15-24 age disability group and 51.1% for 55-64 age disability group, which demonstrates the long-run improvement of education levels in South Africa. On the other hand, the gap between disability and non-disability groups is larger in the younger group, e.g., 11.7 percentage points for 15-24 age group and 5.2 percentage points for 55-64 age group. This might indicate the emergence of children with disabilities left behind in the nation-wide trend. Here, it should be noted that current disability status might have less influence on education level, particularly of the elderly, because some persons with disabilities might have received impairments after the graduation from school. In that case, the causality works from education level to disability, but not from disability to education level. Since the ratio of such persons is considered to be higher in the older group, the genuine impact of disability seems to be smaller than the estimates here. As for labor market status, the gap is larger for 25-39 and 40-54 age groups in compared to other younger and older groups. The gap is the largest for 40-54 age group in all indicators of the household level except for access to water, followed by 25-39 age group, showing the larger influences of disability at the core working-age groups. These results are the reason of the larger gap in the adjusted headcount ratio for 25-39 and 40-54 age groups found above. Although South Africa has the disability grant program as mentioned above, the findings of this paper suggest that the current system might not work so well that the living conditions for persons with disabilities are guaranteed at the same level of those without disabilities.

5.2 Disaggregated analysis of the adjusted headcount ratio

Table 6 compares the adjusted headcount ratio by the subgroups of type and severity of disability. As for type of disability, the gap in the adjusted headcount ratio is larger for persons with severe difficulties in communication, remembering, and multiple difficulties for all age groups. These results are similar to the findings of the existing studies in that persons with intellectual and multiple disabilities are more disadvantaged. The gap is also large for those with walking difficulties for 6-14 and 15-24 age groups, and for those with self-care difficulties for 25-39 and 40-54 age groups. The reason why the difficulties in walking matter for multidimensional poverty of children is because it is strongly related to the deprivation in school attendance, though not reported in this paper. The ratio of children not attending school is the highest for those with severe difficulties in walking, 41.1%, and the gap from those without disabilities is also the largest for them, 34.9 percentage points. This seems to result from inaccessible

transportation system and insufficient reasonable accommodations in school facilities that Human Rights Watch (2015) criticized. As for severity of disability, both the gap and the ratio level itself are larger for persons with severe difficulties than those with moderate ones in most subgroups of age and type of disability. This can be more clearly detected for the younger group, e.g., this holds for all five types of disability for 6-14 age group and all types of disability except for self-care for 15-24 age group. In contrast, the gap is larger for those with moderate difficulties in hearing, communication, and walking for 40-54 age group and in communication and walking for 55-64 age group. These results suggest that older persons with disabilities could cope with the severe difficulties better than younger persons do.

Table 7 compares the adjusted headcount ratio by the subgroups of gender, population group, and type of residence area. Regarding the gender difference in the gap, it is slightly larger for females of 6-14 age group, whereas it is for males of 15 or above age groups. The former result is common to Trani et al (2013) and Trani and Cannings (2013) reporting worse multidimensional poverty of girls with disabilities, and the latter is common to Mitra et al. (2013) showing that the difference in adjusted head count ratio is larger for males with disabilities than females with disabilities in most of analyzed countries. It is also remarkable that the adjusted headcount ratio of females with disabilities is higher than males with disabilities in 40-54 and 55-64 age groups (the tenth and thirteenth columns), and that this is also true of females and males without disabilities (the eleventh and fourteenth columns). These might indicate that older women have been so far facing gender discrimination in South Africa. As a result, females with disabilities are the most multidimensionally deprived among the four groups divided by the disability and gender status in these two groups.

As for the racial difference, the gap is larger for Africans and Coloureds in all age groups, and the ratio itself of these two racial groups is much higher within the disability group. As expected, Africans and Coloureds are more multidimensionally deprived even without disabilities (see the columns of non-disability groups in each age group), and disability additionally expands the gap in poverty conditions among the racial groups. The influences of past racial segregation in South Africa remain so large that Africans and Coloureds without disabilities are more multidimensionally deprived than Indians and Whites with disabilities. Furthermore, note that the gap between disability and non-disability groups is not statistically significant for Indian and White children and Whites in the 40 or above aged groups (the third, twelfth, and fifteenth columns). These might imply that children and older persons with disabilities in these groups could be supported well by their families and those around them.

Regarding the difference by type of residence area, the gap is higher in rural

informal and tribal areas than urban area for all age groups except for 55-64 age group, and the ratio itself of persons with disabilities is much higher in these areas for all age groups. In common with racial difference, the influences of type of residence area are so large that residents without disabilities in rural informal and tribal areas are more multidimensionally deprived than those with disabilities in urban area. Thus, the disadvantages deriving from regional inequality still remains large in South Africa and leads to worse multidimensional poverty through interacting with disability.

5.3 Results of Ñopo decomposition

Table 8 shows the results of Ñopo decomposition of the gap in adjusted headcount ratio between persons with and without disabilities. For 6-14 and 15-24 age groups, about more than 70% of the observed gap is attributable to disability status, and about 30% is to the characteristics specific to persons without disabilities in those age groups. Similarly, the part explained by disability status is large for 25-39 age group, about 71%, though that by observable characteristics is also unignorable, about 28%. In contrast, the part explained by disability status is lower for the two oldest groups than younger groups, whereas the contribution of other parts resulting from observable characteristics is larger. This difference in the influences of disability status by age group might derive from the following three reasons. Firstly, as a person is more likely to acquire an impairment at higher ages as presented by Figure 1, a larger part of the living conditions of older persons could be determined before having impairments by other characteristics such as gender, race, and place of residence. On the other hand, as younger persons with disabilities are not subject to other disadvantages for long time, their influences are considered to be not as strong as disability. The second possible reason is associated with the causality from poverty to disability. Aforementioned, the disadvantaged is more likely to acquire impairments, and it is reasonable to assume that this tendency becomes stronger as a person ages due to the interaction with aging and the accumulation of experiences of social exclusion and discrimination. In fact, we observed in Table 2 that females, Africans, and residents in the tribal area are more represented in the older disability group. Thus, it could be said that the causality from poverty to disability is stronger for older groups than for younger groups. Lastly, the composition of type of disability differs by age group. The ratio of persons with moderate difficulties in seeing is higher in older group as shown by Table 1, and the influences are found to be smaller as shown by Table 6. Consequently, the influences of disability are estimated as smaller for older groups, resulting in less significance of disability for the whole poverty gap.

It is also remarkable that the gaps deriving from the difference in characteristics

between matched and unmatched persons are consistently negative for persons with disabilities, and positive for those without disabilities. By the definition of each term, this means that matched persons are more multidimensionally deprived than unmatched ones in both groups. Putting differently, those with more disadvantageous characteristics were matched within each group. This result did not change even if the ratio of successful matching improved through relaxing the conditions of matching from the exact value of age to age categories such as 6-14, 15-19, 20-24, …, 60-64. The fact that persons with and without disabilities in the common support is more deprived than those in the out-of support indicates that the variables used for matching and their combinations correctly reflected the poverty conditions in South Africa. It can be also said that persons without disabilities dissimilar to those with disabilities are less deprived, implying that such non-disabled persons have the favorable characteristics. Interestingly, this is true of persons with disabilities: those dissimilar to persons without disabilities might be well-endowed with the personal and environmental characteristics. By comparing matched and unmatched persons, I detected that, irrespective of disability status and age groups, the matching rate is lower in the urban and rural formal areas than the tribal area. As mentioned above, the residents in the tribal area are basically Africans. The other two areas are relatively more diversified in the population and so that in these areas there seem to be persons with and without disabilities who are less deprived due to their advantageous characteristics.

6. Conclusions

Disability and poverty are complicatedly entangled with each other. In this paper, the matching and decomposition analyses were conducted to provide the more accurate gap in multidimensional poverty between persons with and without disabilities in South Africa. Through exact covariate matching, the gap in the headcount ratio between persons with and without disabilities is found to be larger than in average deprivation share, implying that disability has larger influences on the breadth of poverty. In controlling for other factors by this analysis, the prevalence of persons with disabilities is found to be higher among those considered disadvantaged in South Africa, which suggest the causality from poverty to disability. As for the gap by indicators, persons with disabilities are found to be more deprived in the individual-level indicators such as education and employment, and the deprivation in the household-level indicators are found to be larger for the core working-age (25-54) group of persons with disabilities. According to the subgroup analysis, persons with disabilities who are more largely affected by disability are those with difficulties in intellectual functionings and multiple difficulties, males aged 15 or above, Africans, Coloureds, and residents in rural

informal or tribal areas. Especially, for Africans, Coloureds, and residents in rural informal or tribal areas, not only the gap, but also the level of multidimensional poverty itself is much higher than other groups. This implies the disadvantages increased by the interaction of disability, race, and regional inequality, i.e., the existence of multiple discrimination. The matching-based decomposition analysis revealed that a large portion of the gap in poverty among younger groups can be explained by disability, whereas the gap among older groups can be explained by both disability and other observable factors. This difference by age groups seems to reflect the difference in experience of gender and racial discrimination and regional disadvantages. Thus, it is reasonable to consider that poverty conditions previously existing before acquiring impairments have a larger influence on the lives of older people in South Africa.

It might be possible to draw several policy implications from the findings of this paper. Firstly, comprehensive approach is necessary for improving the wellbeing of persons with disabilities, but not just disability-specific approach. The finding that persons with disabilities are more multidimensionally deprived than those without disabilities who have almost similar characteristics highlights social barriers against persons with disabilities, appealing the necessity of social change. In addition, taking into account the results that persons with disabilities are even more deprived among Africans and Coloureds and residents in rural informal or tribal areas, the government should advance the mainstreaming of disability in existing policies promoting equity among racial groups and regions. Secondly, the disadvantages deriving from disability could differ within persons with disabilities by the type of difficulties so that it is essential to pay more attention to who is more affected by disability when building the policies and legislation and providing the social services, e.g., those with difficulties in intellectual functionings and multiple difficulties in South Africa. This paper also found that disability account for a large part of the gap in poverty between persons with and without disabilities for younger groups, South African government should make efforts to support the youth with disabilities in education and employment. Lastly, the the possibility indicated by the analysis that the poor is more likely to have impairments seems to require not only coping with disability already existing, but also promoting early detection and treatment of health problems of the poor through improving their access to medical and social security services.

Although this paper closely examined the poverty of persons with disabilities with novel empirical methods and large-scale data, there are several issues left behind for future research due to the limitation of the methods and data. Firstly, in order to evaluate the causal impact of disability by controlling for unobservable factors, we should adopt other econometric methods such as the instrumental variable method

utilizing the naturally occurring situation where a historical event or a natural or institutional condition is strongly associated with the likelihood of having impairments, but not directly associated with the poverty conditions. Secondly, since this paper depends on a cross-sectional data and the information about the timing and cause of having impairments is not available in the data, it is impossible to explore the dynamics of poverty of persons with disabilities and the coping strategies they and their family might have adopted including public social security services. Finally, the limited number of variables in the data from the population census narrowed the coverage of the analysis of this paper with regard to type of disability and poverty indicator. Although the Washington group short set of disability questions is usable and cost-effective, and in fact the validity was demonstrated by the existing studies, it does not have a specific question about mental health. Similarly, this paper could not investigate the poverty of persons with disabilities from the psychological perspective such as subjective well-being, hope, and self-esteem. Since mental conditions and subjective preference seem to be an important factor in their decision making across the lifespan, examining these aspects contributes to deepening our understanding of disability and poverty.

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Table 1. Share of persons with disabilities by type and severity of difficulty among disability group

	Age:				
	6-14	15-24	25-39	40-54	55-64
	(1)	(2)	(3)	(4)	(5)
Those with difficulties in (%)					
Seeing: moderate	21.2	30.7	36.0	50.2	51.0
severe	5.4	6.0	5.5	3.4	3.5
Hearing: moderate	13.2	12.2	12.4	10.9	12.5
severe	5.8	6.3	5.2	2.5	1.9
Communication: moderate	15.0	9.9	7.3	4.3	3.3
severe	11.9	8.1	5.7	2.3	1.7
Walking: moderate	6.3	8.1	13.2	18.1	22.8
severe	8.9	7.9	6.9	4.4	4.6
Remembering: moderate	30.2	16.5	15.8	17.7	20.8
severe	14.2	7.6	5.1	2.6	2.2
Self-care: moderate		9.7	7.6	5.8	6.0
severe		13.2	7.8	4.1	4.2
Multiple functionings	20.6	20.6	17.6	18.5	23.8
Number of observations	14,400	12,224	16,967	26,682	20,594

Source: Author's calculations using the 10% sample data of South African census in 2011.
Note: Reported are the shares of persons with each difficulty within each age group.

Table 2: Characteristics of persons with and without disabilities in gender, race, and residence area in each age group

	Age: 6-14		Age: 15-24		Age: 25-39		Age: 40-54		Age: 55-64	
	PWD	Non-PWD	PWD	Non-PWD	PWD	Non-PWD	PWD	Non-PWD	PWD	Non-PWD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Gender (%)										
Male	53.1	50.5	50.0	49.8	47.7	49.2	40.3	47.2	40.0	46.1
Female	46.9	49.5	50.0	50.2	52.3	50.8	59.7	52.8	60.0	53.9
Race (%)										
African	90.5	84.0	87.4	84.5	85.3	80.9	82.9	71.8	81.4	65.3
Coloured	5.7	8.9	7.0	8.3	7.3	8.6	9.6	11.5	9.4	10.4
Indian	1.2	1.8	1.7	2.0	2.3	2.7	2.2	3.4	2.4	3.9
White	2.6	5.3	3.8	5.2	5.1	7.8	5.2	13.3	6.8	20.4
Residence area (%)										
Urban area	47.0	54.4	54.9	59.0	62.9	70.8	61.3	70.4	57.4	65.6
Rural formal area	3.4	3.5	3.5	3.6	4.1	4.1	4.5	4.2	4.4	4.1
Tribal area	49.5	42.1	41.7	37.4	33.0	25.1	34.2	25.4	38.3	30.3
Number of obs.	14,400	555,054	12,224	702,168	16,967	809,162	26,682	444,276	20,594	147,472

Source: Author's calculations using the 10% sample data of South African census in 2011.
Note: "PWD" stands for persons with disabilities. Reported are the shares of persons with each characteristic within disability and non-disability groups in each age group.

Table 3. Dimensions, indicators, deprivation cutoffs, and weight for multidimensional poverty measures

Dimension	Indicator	Deprivation cutoff	Weight for aged 6-14/aged >14
Education	School attendance: if aged 6-14	Not attended school	$\frac{1}{3}$ / -
	Years of schooling: if aged >14	Not completed 5 years of education	- / $\frac{1}{4}$
Employment	Labor market status: if aged >14	Not employed AND not "unemployed"[a]	- / $\frac{1}{4}$
Economic well-being	Assets	Own zero or only one of the "small assets" AND does not own a motorcar[b]	$\frac{1}{6}$ / $\frac{1}{8}$
	Household income	Monthly household income per capita is lower than 501 Rand[c]	$\frac{1}{6}$ / $\frac{1}{8}$
Living standards	Type of dwelling	Informal or traditional dwelling	$\frac{1}{21}$ / $\frac{1}{28}$
	Access to water	No access to piped water	$\frac{1}{21}$ / $\frac{1}{28}$
	Type of toilet	Not flush, chemical, pit, nor bucket latrine	$\frac{1}{21}$ / $\frac{1}{28}$
	Cooking fuel	Neither electricity, gas, nor paraffin	$\frac{1}{21}$ / $\frac{1}{28}$
	Heating fuel	Neither electricity, gas, nor paraffin	$\frac{1}{21}$ / $\frac{1}{28}$
	Type of lighting	Not electricity	$\frac{1}{21}$ / $\frac{1}{28}$
	Access to information	No access to internet	$\frac{1}{21}$ / $\frac{1}{28}$

Note: a: A person is defined as "unemployed" if s/he is not employed, but searches for a job and is prepared to start to work if a job offered. A person is defined as not deprived in this indicator if the reason for not searching for a job is health reasons, student, trainee, housewife, or being too old or young, or retirement. b: "Small assets" include refrigerator, electric/gas stove, vacuum cleaner, washing machine, computer, television, satellite television, DVD player, radio, telephone, cell phone. c: This criteria depends on the lower bound of national poverty line in 2011 (Statistics South Africa, 2015b).

Table 4. Comparison in multidimensional poverty measures between persons with and without disabilities before and after matching

	Before			After		
	PWD	Non-PWD	Gap Δ	Matched PWD	Matched non-PWD	Gap Δ_{ATT}
	(1)	(2)	(3)	(4)	(5)	(6)
Headcount ratio						
Age 6-14	0.258	0.164	0.094	0.264	0.198	0.066
15-24	0.482	0.378	0.105	0.497	0.425	0.072
25-39	0.364	0.208	0.157	0.375	0.268	0.107
40-54	0.461	0.264	0.197	0.471	0.375	0.096
55-64	0.586	0.395	0.191	0.604	0.534	0.070
Average deprivation share						
Age 6-14	0.559	0.529	0.030	0.559	0.533	0.026
15-24	0.542	0.501	0.041	0.542	0.503	0.039
25-39	0.569	0.525	0.044	0.571	0.522	0.050
40-54	0.594	0.566	0.028	0.597	0.570	0.028
55-64	0.611	0.599	0.012	0.613	0.605	0.008
Adjusted headcount ratio						
Age 6-14	0.144	0.087	0.058	0.147	0.105	0.042
15-24	0.261	0.189	0.072	0.269	0.215	0.055
25-39	0.207	0.109	0.098	0.214	0.144	0.070
40-54	0.274	0.149	0.125	0.281	0.219	0.062
55-64	0.358	0.237	0.121	0.370	0.325	0.045

Source: Author's calculations using the 10% sample data of South African census in 2011.
Note: "PWD" stands for persons with disabilities. Reported in the columns (1) and (2) are the values of each measure of persons with and without disabilities in each age group, and those in the columns (3) are the difference in the values in the columns (1) and (2). Reported in the columns (4) and (5) are the values of each measure of matched persons with and without disabilities by in each age group, and those in the columns (6) are the difference in the values in the columns (4) and (5). All of the gaps before and after matching were statistically significant at 1% level.

Table 5. Deprivation of matched persons with and without disabilities by indicator

	Age: 6-14			Age: 15-24			Age: 25-39			Age: 40-54			Age: 55-64		
	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Deprived in (%)															
School attendance	13.9	5.5	8.4												
Years of schooling				16.2	4.5	11.7	21.4	9.9	11.4	36.9	28.7	8.2	51.1	45.9	5.2
Labor market status				68.7	64.8	3.9	43.4	32.7	10.7	49.1	38.2	10.9	69.9	61.6	8.4
Assets	11.4	10.5	0.9	9.9	8.8	1.1	11.0	8.3	2.6	11.8	8.8	3.1	11.2	9.2	2.0
Household income	71.5	70.2	1.3	63.7	63.4	0.3†	53.9	51.9	2.0	55.2	52.3	2.9	50.3	50.7	-0.4†
Type of dwelling	27.8	26.5	1.3	25.3	24.3	1.1	26.3	24.0	2.3	25.2	22.2	3.0	23.8	22.4	1.3
Access to water	18.1	16.9	1.1	15.4	13.9	1.5	11.5	10.7	0.8	12.0	11.1	0.9	13.0	12.4	0.5
Type of toilet	11.8	10.5	1.3	10.2	8.6	1.6	9.1	7.7	1.4	9.4	7.5	1.8	9.2	7.6	1.5
Cooking fuel	32.0	29.8	2.2	25.4	23.1	2.3	19.6	16.6	3.0	20.9	17.8	3.1	23.3	21.2	2.0
Heating fuel	48.2	44.1	4.0	41.9	38.1	3.9	38.2	32.2	5.9	39.5	32.4	7.1	41.3	34.9	6.4
Type of lighting	20.2	19.1	1.1	17.6	16.2	1.4	17.4	14.9	2.5	17.1	14.7	2.4	16.0	14.3	1.7
Access to information	75.4	72.6	2.8	69.4	66.6	2.8	70.4	65.9	4.5	74.7	67.8	6.9	77.0	70.8	6.2

Source: Author's calculations using the 10% sample data of South African census in 2011.
Note: "PWD" stands for persons with disabilities. Reported are the shares of matched persons with and without disabilities who are deprived in each indicator, and the differences in the shares between them. All of the gaps were statistically significant at 5% level except for the gap marked with "†."

Table 6. Disaggregated analysis of adjusted headcount ratio of persons with and without disabilities by type and severity of difficulty

	Age: 6-14			Age: 15-24			Age: 25-39			Age: 40-54			Age: 55-64		
	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Seeing: moderate	.087	.079	.007†	.198	.189	.009†	.135	.122	.013	.230	.206	.024	.328	.307	.021
severe	.209	.146	.063	.305	.249	.056	.206	.152	.054	.283	.225	.059	.422	.323	.099
Hearing: moderate	.160	.123	.037	.292	.228	.064	.248	.155	.093	.325	.224	.101	.426	.338	.088
severe	.235	.143	.092	.335	.255	.080	.228	.163	.065	.318	.233	.086	.455	.342	.112
Communication: moderate	.192	.119	.072	.348	.222	.126	.363	.170	.193	.392	.236	.156	.452	.344	.108
severe	.235	.117	.118	.393	.232	.160	.345	.165	.180	.389	.244	.144	.429	.338	.091
Walking: moderate	.199	.112	.087	.292	.221	.071	.247	.155	.092	.328	.219	.109	.384	.323	.061
severe	.264	.112	.153	.347	.225	.122	.264	.149	.115	.308	.210	.098	.377	.318	.058
Remembering: moderate	.149	.103	.046	.343	.226	.117	.331	.180	.152	.394	.278	.116	.458	.386	.072
severe	.212	.106	.106	.383	.230	.153	.342	.164	.178	.385	.241	.144	.478	.349	.129
Self-care: moderate				.346	.237	.110	.318	.174	.144	.382	.240	.142	.447	.360	.087
severe				.329	.223	.106	.343	.163	.180	.384	.223	.161	.459	.353	.106
Multiple difficulties	.239	.119	.121	.381	.234	.148	.353	.174	.179	.380	.248	.132	.429	.354	.076

Source: Author's calculations using the 10% sample data of South African census in 2011.
Note: "PWD" stands for persons with disabilities. Reported are the adjusted headcount ratios of matched persons with each difficulty and those without disabilities, and the differences in the ratios between them. All of the gaps were statistically significant at 1% level except for the gap marked with "†."

Table 7. Disaggregated analysis of adjusted headcount ratio of persons with and without disabilities by gender, race, and residence area

	Age: 6-14			Age: 15-24			Age: 25-39			Age: 40-54			Age: 55-64		
	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap	PWD	Non-PWD	Gap
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Male	.145	.105	.040	.278	.215	.063	.218	.134	.084	.262	.182	.081	.345	.286	.059
Female	.151	.106	.045	.261	.213	.049	.211	.156	.056	.294	.243	.051	.386	.348	.038
African	.156	.111	.044	.289	.232	.057	.230	.160	.070	.309	.244	.065	.409	.362	.047
Coloured	.070	.043	.027	.155	.100	.055	.166	.072	.094	.187	.118	.069	.247	.183	.064
Indian	.030	.022	.009†	.075	.036	.039	.066	.028	.038	.073	.044	.029	.125	.090	.035
White	.012	.017	-.004†	.064	.020	.044	.035	.015	.020	.021	.015	.006†	.023	.023	.0001†
Urban area	.081	.049	.032	.169	.124	.045	.135	.077	.057	.184	.123	.061	.253	.197	.056
Rural formal area	.322	.244	.078	.359	.298	.061	.321	.231	.090	.413	.323	.090	.495	.465	.030†
Tribal area	.197	.147	.049	.389	.320	.069	.350	.260	.089	.434	.370	.063	.521	.487	.034

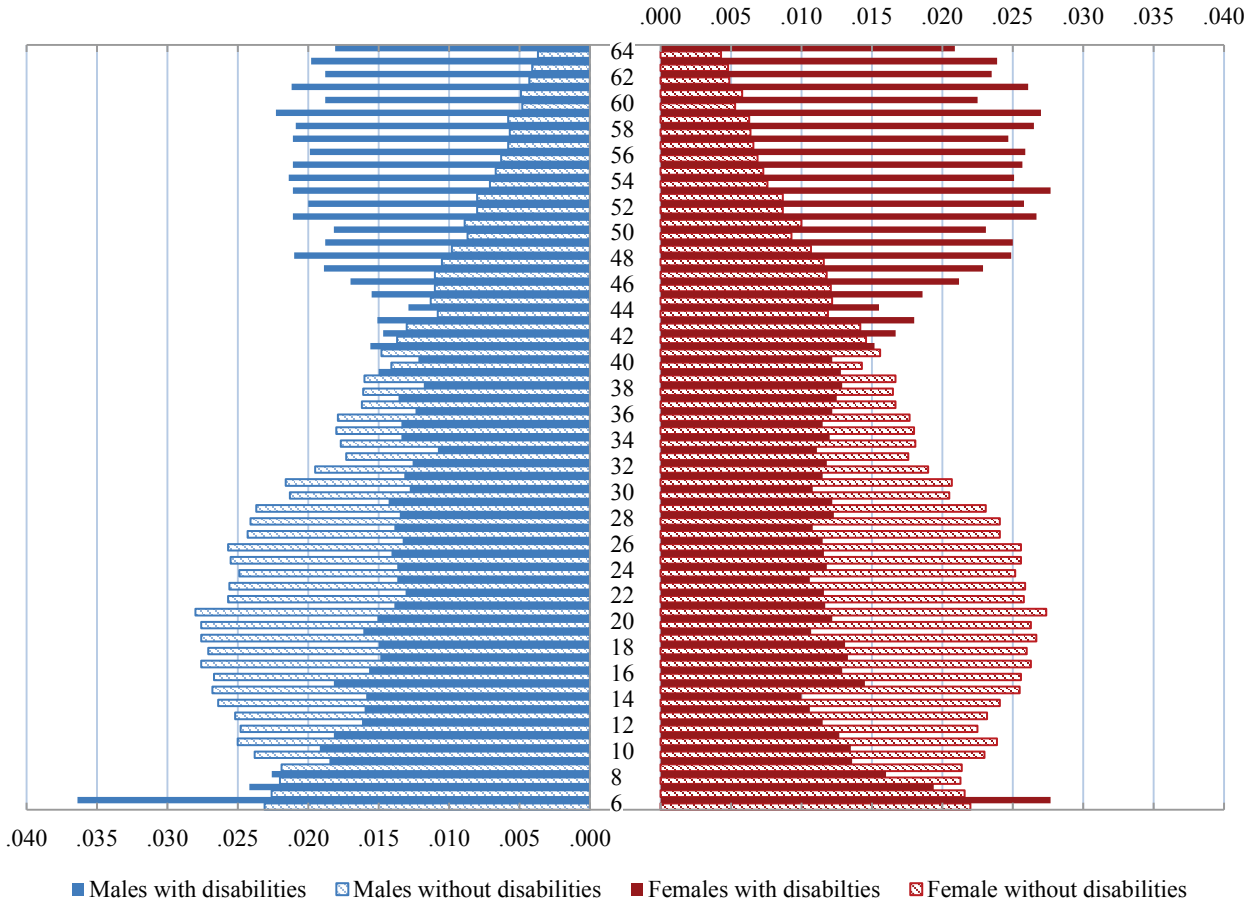
Source: Author's calculations using the 10% sample data of South African census in 2011.
Note: "PWD" stands for persons with disabilities. Reported are the adjusted headcount ratios of matched persons with and without disabilities categorized by each characteristic, and the differences in the ratios between them. All of the gaps were statistically significant at 1% level except for the gap marked with "†."

Table 8. Decomposition of the gap in adjusted headcount ratio between persons with and without disabilities

	Age: 6-14		Age: 15-24		Age: 25-39		Age: 40-54		Age: 55-64	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Total gap: Δ	.058		.072		.098		.125		.121	
$\Delta_0 = \Delta_{ATT}$	.042	73.2%	.055	75.9%	.070	71.4%	.062	50.1%	.045	36.9%
	(.002)		(.003)		(.003)		(.002)		(.003)	
Δ_X	.001	1.1%	.003	3.6%	.027	27.6%	.050	40.2%	.046	38.0%
	(.001)		(.001)		(.001)		(.001)		(.001)	
Δ_w	-.003	-5.5%	-.008	-11.5%	-.007	-7.1%	-.007	-5.9%	-.012	-10.1%
	(.001)		(.001)		(.001)		(.001)		(.001)	
$\Delta_{w/o}$	.018	31.1%	.023	31.9%	.008	8.0%	.019	15.5%	.043	35.3%
	(.0004)		(.0003)		(.0003)		(.0004)		(.001)	
Ratio of matched PWD	82.3%		88.2%		83.3%		81.8%		78.6%	
Ratio of matched non-PWD	31.1%		54.1%		40.9%		47.0%		51.1%	

Source: Author's calculations using the 10% sample data of South African census in 2011.
Note: "PWD" stands for persons with disabilities. Reported in the odd-numbered columns are the total gaps in adjusted headcount ratio between persons with and without disabilities, the estimates of each decomposed part, and those in parentheses are standard errors estimated by the bootstrap method with 100 replicates. Reported in the even-numbered columns are the percentages of each decomposed part accounts for the total gap.

Figure 1. Age distribution of persons with and without disabilities by gender



Source: Prepared by author using the 10% sample data of South African census in 2011.