Essays on Culture, Economic Outcome and Wellbeing

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Abstract

Chapter 1: The Impact of Culture on the Second-Generation Immigrants' Level of Trust in Canada

Trust is one of the main elements of social capital; it determines the extent to which an individual cooperates with others. In this chapter, I assess whether cultural factors influence the level of trust in the population of second-generation immigrants in Canada. This paper is related to two strands of empirical literature. The first analyses the determinants of trust and the second studies the cultural transmission of values, attitudes and beliefs. I follow closely the literature on the cultural transmission and use an epidemiological approach to assess whether trust of second-generation immigrants is affected by their cultural heritage. This approach consists of comparing information about the outcomes of second-generation immigrants with that of the country of origin of their ancestry. We apply this approach using the Ethnic Diversity Survey (EDS), the World Value Survey (WVS) and the European Value Survey (EVS). Estimation results show that the average level of trust in the countries of origin of the ancestors of the second-generation immigrants has a strong significant impact on their level of trust. Thus, individual whose country of ancestry displays a high level of trust, tend to have a high level of trust. This provides evidence that individuals' level of trust is not only explained by their personal experiences, characteristics, and the environment in which they live; but also by the culture in their country of ancestry. This means that culture does matter! I find that the results remain robust even if certain key countries are omitted or a different data set is used.

Chapter 2: Decomposing Health Achievement and Socioeconomic Health Inequalities in Presence of Multiple Categorical Information

This chapter presents a decomposition of the health achievement and the socioeconomic health inequality indices by multiple categorical variables and by regions. I adopt Makdissi and Yazbeck's (2014) counting approach to deal with the ordinal nature of the data of the United States National Health Interview Survey 2010. The findings suggest that the attributes that contribute the most to the deviation from perfect health in the United States are: anxiety, depression and exhaustion. Also, I find that the attributes that contribute the most to the total socioeconomic health inequality are ambulation, depression and pain. The regional decomposition results suggest that, if the aversion to socioeconomic health inequality is high enough, socioeconomic health inequalities between regions are the main contributors to the total socioeconomic health inequality in the United States.

Chapter 3: Accounting for Freedom and Economic Resources in the Assessment of Changes in Women Poverty in Sub-Saharan Africa

This chapter assesses the importance of freedom in women's wellbeing in twelve Sub-Saharan Africa countries by using data from Demographic Health Surveys. This paper presents a poverty comparison by using the stochastic dominance approach and relies on the economic resources and freedom as the two aspects of wellbeing which evokes the multidimensionality of poverty. This study is related to the following three pieces of literature: the sequential stochastic dominance, the multidimensional poverty, the Sen's capability approach which is based on freedom. This paper is built on Makdissi *et al*. (2014) but differs from it in a number of respects. First, it focuses on poverty instead of welfare. Secondly, it applies the Shapley decomposition to determine the contributions of the economic resource distribution and the incidence of the threat of domestic violence to poverty changes over time. Consistent with previous work on the importance of freedom, I find that more freedom, i.e. less threat of domestic violence, affects women's wellbeing positively since it decreases women's poverty. The results indicate that women's wellbeing has improved in Burkina Faso, Ghana, Kenya, Lesotho, Madagascar, Malawi, Rwanda, Senegal, and Zimbabwe and deteriorated in Ethiopia, Nigeria and Tanzania.

To my daughter Sogona, my dad, my mom, my brothers and my sister.

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General Introduction

There is a consensus among researchers about the multidimensionality of human wellbeing (objective and subjective dimensions). The Stiglitz-Sen-Fitoussi Commission on the measurement of economic performance and social progress (Stiglitz *et al.*, 2009, p.14-15) considers the following dimensions when measuring human wellbeing: (a) Material living standards (income, consumption and wealth), (b) Health; (c) Education; (d) Personal activities including work (e) Political voice and governance; (f) Social connections and relationships; (g) Environment (present and future conditions); and (h) Insecurity, of an economic as well as a physical nature. Trust, freedom and health are the three specific aspects of human wellbeing addressed in this dissertation. This doctoral dissertation, titled "Essays on Culture, Economic Outcome and Wellbeing", includes three independent chapters. The first chapter examines whether cultural factors influence the level of trust in the population of second-generation immigrants in Canada. The second chapter focuses on the decomposition of the health achievement and the socioeconomic health inequality indices by multiple categorical variables and by regions in United States. The last chapter assesses the importance of freedom in women's wellbeing in twelve Sub-Saharan Africa countries.

The first chapter investigates whether culture affects the level of trust of second-generation immigrants in Canada. Trust is one of the main elements of social capital. Research has shown that trust has a positive impact on economic growth (Algan and Cahuc, 2010), financial development, probability of becoming entrepreneur and economic exchanges (Guizo *et al*., 2004, 2006, 2009) and wellbeing (Helliwell and Wang, 2010). The presence of interpersonal trust decreases the transaction costs (Alesina and La Ferrara, 2002). Moreover, the quality of economic policies is enhanced by trust (Putman, 1993).

Research on cultural economics focuses on the intergenerational transmission of cultural traits. Fernandez and Fogli (2009) use the epidemiological approach to show that culture has a positive and significant effect on women's work outcomes, i.e. women tend to have low labour market participation when the female labour market participation in their country of origin is low. Giuliano (2007) provides evidence that the living arrangement of the second generation immigrants in United States reflects the one

prevailing in their parents' country of origin. This paper contributes to the literature on cultural transmission by focusing on a different cultural trait: trust. This paper will help verify if the difference in level of trust among second-generation immigrants can be explained by culture. To achieve this objective, I use the Ethnic Diversity Survey (EDS) of Canada to extract information about second-generation immigrants (their level of trust and their individual characteristics). I then use the World Value Survey (WVS) and the European Value Survey (EVS) to obtain the trust value in the country of origin. This paper also complements the empirical literature on the determinants of trust (Alesina and La Ferrara, 2002; Nunn and Wantchekon, 2011). To the best of my knowledge, nobody has so far attempted to study the intergenerational transmission of trust in the Canadian context.

The empirical work is carried out using the epidemiological approach to assess whether trust of second-generation immigrants is affected by their cultural heritage. This approach consists of verifying whether the attitudes and beliefs of second-generation immigrants reflects the ones in their country of ancestry. After controlling for individual experiences and characteristics, the estimation results show that the average level of trust in the country of origin of the second-generation immigrants has a significant impact on their level of trust. This provides evidence that individuals' level of trust is not only explained by their personal experiences, characteristics, and the environment in which they live; but also by the culture in their country of ancestry. We also test the robustness of our results, (*i*) by replacing average level of trust in the country of origin by country dummies; (*ii*) by omitting individuals whose countries of origin are Great Britain and France or by excluding individuals from Nordic countries; (*iii*) by using the Canadian General Social Survey of 2003.

The purpose of the second chapter is to present a decomposition of the health achievement and the socioeconomic health inequality indices by multiple categorical variables and by regions. Health inequality measurement is essential for the implementation and the monitoring of health policies. The decomposition allows the population group in need to be targeted so as to identify the health and the socioeconomic characteristics contributing to the health inequality (Lauridsen *et al*., 2007).

Reducing health inequalities between socioeconomic groups has become a mainstay of health policy makers in most of the countries in the world. However, the concentration index, which is one of the most used measure of socioeconomic health inequality in health economic studies has some shortcomings. First, it does not account for the average level of health status in the population considered (Wagstaff, 2002). To overcome this problem, Wagstaff (2002) recommends the use of an achievement index that captures simultaneously the average level of health status and the socioeconomic inequality of its distribution. Second, the use of concentration index leads to arbitrary ranking between health distributions (Erreygers, 2006; Zheng, 2008). Makdissi and Yazbeck (2014) suggest a solution that consists of using a counting approach that focuses on the breadth of health problems and produces consistent values and rankings.

This paper use Makdissi and Yazbeck's (2014) counting approach to decompose the health achievement and the socioeconomic health inequality indices, by categories of health problems and by regions. This study support the work of Clarke *et al.* (2003), but it differs from it in a number of respects. First, I use Makdissi and Yazbeck's (2014) counting approach to assess individual health statuses, whilst Clarke *et al.* (2003) use a health related quality of life index (the SF-36). Second, I decompose the health achievement indices, while Clarke *et al.* (2003) only focus on socioeconomic health inequality. Finally, the empirical application used in this study is based on United States data, while Clarke *et al.* (2003) use Australian data. The results indicate that anxiety, depression and exhaustion are the main contributors to the deviation from perfect health in the United States. Furthermore, ambulation, depression and pain play major role in total socioeconomic health inequality. For regional decomposition, socioeconomic health inequalities between regions have a considerable contribution to the total socioeconomic health inequality when the parameter of socioeconomic health inequality aversion becomes higher.

The third chapter examines the importance of freedom in women's wellbeing in twelve Sub-Saharan Africa countries. This paper is motivated by the importance of freedom in social, political, cultural and economic life of people. The threat of domestic violence and domestic violence itself reduce people's capability set (Anand *et al.*, 2008). Agarwal and Panda (2007) show the importance of freedom from

domestic violence for human development, especially for women's wellbeing. Anand *et al.* (2008) found that the threat of violence undermines women's wellbeing. Freedom is the foundation of Sen's capability approach as well as the key to development (Sen, 1999).The capability approach measures a person's wellbeing by his/her ability and freedom to do things that he/she values and to be what he/she wants. It reveals multidimensionality of individual wellbeing, i.e. a person's wellbeing depends both on his market-based capabilities such as the necessary income to afford basics needs and non-market capabilities such as freedom to vote (Foster and Handy, 2008). The violation of one's freedom may decrease a person capability (Sen, 1992, p.87).

Sen (1999, 2002, 2009) has two different ways of viewing freedom: the opportunity and the process aspects of freedom. The opportunity aspect of freedom concentrates on the individual's ability to achieve what he/she values. In the process aspect of freedom, it is the freedom to choose by oneself that is valuable. A large reduction of ones opportunities inhibits one's opportunity aspect of freedom while the process aspect of freedom is undermined if one cannot decide by oneself what to do (Sen, 2009, p.228). Sen (2002, p.596) sees the opportunity aspect of freedom as the "freedom to achieve" through one's own actions and those of others and the process aspect as the "freedom to act" which determines an individual's autonomy and his/her immunity from intrusion. The capability approach can be used to analyze the opportunity aspect of freedom but not the process aspect of freedom (Sen, 2009, p.371). The limit in the application of the capability approach is explained by data restrictions in measuring freedom. Makdissi *et al.* (2014) measure individual freedom by exploring the information on the threat of domestic violence to assess the extent of women's freedom. They contribute to the empirical literature of the capability approach by reconciling the capability approach and the process aspect of freedom since they measure women's wellbeing with their access to economic resources and their freedom within their households.

This paper draws on Makdissi *et al.*'s (2014) use of the stochastic dominance approach to measure the temporal change in women's poverty based on their access to economic resource and their freedom within their household, which evokes the multidimensionality of the poverty. This paper differ from Makdissi *et al.* (2014) in a number of respects. First, it focuses on poverty instead of welfare. Second, it

applies the Shapley decomposition to determine the contributions of the distribution of economic resources and the incidence of the threat of domestic violence to poverty changes over time. The change of poverty over time may be explained by the change in the incidence of the threat of domestic violence or by the change in the distribution of economic resource or by both. This paper supports the work of Duclos *et al.* (2007), who suggested a multidimensional poverty measure that includes discrete variables among its attributes. In their study, they focus on the following discrete variables: household size, adult literacy, area of residence, education status and health status. This paper differs from them since it concentrates on freedom as the discrete variable.

This research is carried out using the Demographic Health Survey data of twelve Sub-Saharan Africa countries. Like previous research, I find that more freedom, i.e. less threat of domestic violence, affects women's wellbeing positively since it decreases women's poverty. The results indicate that women's wellbeing has been improved in Burkina Faso, Ghana, Kenya, Lesotho, Madagascar, Malawi, Rwanda, Senegal, and Zimbabwe and deteriorated in Ethiopia, Nigeria and Tanzania.

Chapter 1

The Impact of Culture on the Second-Generation Immigrants' Level of Trust in Canada[1]

[1] This chapter draws on the work of a joint research project with Dr. Myra Yazbeck.

1.1 Introduction

Trust is one of the main elements of social capital; it determines the extent to which an individual cooperate with others. Its impact on individual behaviours affects how the society allocates scarce resources and thus many economic outcomes. Recently, there has been an increased interest in the role of culture in general and trust in particular in economic performance. Some researchers focused on the impact of trust on individual labour market outcomes such as the probability of becoming an entrepreneur (Guiso *et al.*, 2006) as well as wellbeing (Helliwell and Wang, 2010). Other researchers studied its impact on countries' level of economic performance (e.g., economic growth, trade).[2] Overall, there appear to be a consensus on the positive role of trust in good economic performance.

A more general line of research in the field of cultural economics introduces culturally based explanations to provide new insights for some of the observed economic phenomena. Part of this research area has actively investigated the role of cultural traits (through different channels) in economic outcomes and economic preferences.[3] Particular attention was given to the role of cultural heritage in determining women's labour market participation through fertility decisions (Fernandez and Fogli, 2006; Fernandez and Fogli, 2009). Fernandez and Fogli (2009) find evidence that culture has a positive and significant effect on womens' work outcomes. More specifically, women tend to have low labour market participation when the female labour market participation in their country of origin is low. These findings are consistent with previous work by Fernandez and Fogli (2006) who shows that conservative attitudes towards work in the country of origin decreases hours of work in the host country. In the same spirit, Algan and Cahuc (2007) and Alesina and Giuliano (2011) assess the impact of family structure/ties on labour market outcomes. They provide evidence that immigrants with strong family values/ties have lower labour market participation. In these papers, family values represent cultural traits in the country of origin.

[2] See Knack and Kefeer (1997), Zak and Knack (2001), Alesina and La Ferrara (2002), Guiso *et al*. (2004, 2006, 2008a, 2009), Aghion *et al.* (2010), Algan and Cahuc (2007, 2010), Tabellini (2007, 2010) among others.
[3] See Caroll *et al.* (1994), Guiso *et al*. (2004), Fernandez *et al*. (2004), Fernandez and Fogli (2007, 2009), Alesina and Guiliano (2007, 2010), Guiso *et al*. (2006, 2009), Tabellini (2008a), Algan and Cahuc (2010), Giavazzi *et al*. (2009).

Another part of the cultural economics literature has emphasized the importance of the transmission of cultural traits, attitudes and values (e.g., generalized morality) both theoretically and empirically.[4] It provides evidence that cultural values evolve over time but tend to persist over generations.[5] This paper is motivated by the importance of the role of culture in economic outcomes in general and labour market outcomes in particular. It seeks evidence to answer the following question: Can we consider the perception of trust as one of the persisting cultural values? To this end, we assess whether cultural factors influence the level of trust in the population of second-generation immigrants in Canada.[6]

The use of Canadian data to explore this research question comes in very handy as it provides us with a setting where immigrants from ethnically diverse origins are well integrated. In 1971, the Canadian government explicitly adopted a multiculturalism policy.[7] Consequently, it can be argued that multiculturalism may have given an incentive to increase the attachment to certain ethnic norms and cultural traits and thus slowing down cultural assimilation. An opposite argument can also be made, the transmission of certain cultural traits to second-generation immigrants may have been mitigated and its role in shaping their trust level may have been dampened. In addition, sharing a common institutional and economic environment with the long-generation Canadian born citizens could have played a reinforcing role and pushed for cultural convergence. While we have no strong a-priori about how multiculturalism might have affected the transmission of culture (and trust in particular), empirical evidence seem to suggest (implicitly) that the persistence of certain cultural traits might be behind labour market outcomes and gender preferences in second-generation immigrants in Canada. Aydemir and Sweetman (2008) provide evidence that second generation immigrants in Canada have lower return to individual characteristics when compared to the third generation immigrants. Also, second generation immigrants seem to perpetuate their cultural preferences

[4] See, for instance, Bisin and Verdier (2000, 2001), Bisin *et al*. (2004), Patachini and Zenou (2006), Bisin *et al*. (2006), Tabellini (2008b), Guiso *et al*. (2008a, 2008b).
[5] See, for instance, Algan and Cahuc (2005), Fernandez and Fogli (2006, 2007), Guiso *et al*. (2006), Alesina and Guiliano (2007), Guiliano (2007), Luttmer and Singhal (2009).
[6] We adopt the inherited culture perspective and thus assume that culture is slow-moving. Unlike cultural economics inherited culture perspective, the social interaction perspective is another way to look at the transmission of culture. It approach focuses on the impact of reference groups on culture and emphasizes the importance of social interactions. While we acknowledge the importance of these models, we believe that they are beyond the scope of this paper at this stage.
[7] It should be noted that the Canadian immigration policy has changed since the 1960's. This has changed the immigration patterns in the subsequent decades (for details see Green and Green, 2004).

for male offspring. Almond *et al*. (2013) find evidence that allows for the conclusion that whilst sex selection methods have changed for second-generation immigrants, one cannot reject that they still practice offspring's sex selection. In fact, they substituted the stopping rule with abortion. In this perspective, our paper contributes to the literature on cultural transmission by focusing on a different cultural trait: trust. It will permit to verify if the difference in level of trust among second-generation immigrants can be explained by culture. To achieve this objective, we use the Ethnic Diversity Survey (EDS) which is well suited to explore our research question. EDS covers immigrants from almost the entire world (we have 40 countries and regions) and contains a rich set of individual characteristics as well as interesting individual attributes. We then augment the EDS with trust values in the country of origin from the World Value Survey (WVS) and the European Value Survey (EVS).

We believe that uncovering the presence of intergenerational transmission of trust is important for three main reasons: (1) the identification of the dimensions in which acculturation succeeds or fails is important from an immigration policy perspective. With such information at hand, policy makers may be able to provide targeted policies that might enhance acculturation when deemed important, (2) the presence of interpersonal trust decreases transaction costs (Alesina and La Ferrara, 2002). If high trust levels prevail, individuals will spend less to protect themselves from being exploited, (3) the importance of the role of trust in improving the quality of economic policies (Putman, 1993).

The identification of cultural effects in general and trust in particular is a difficult task that presents many challenges. First, the definition of culture is quite fuzzy. It is thus necessary to provide a tighter definition. In this paper we will refer to culture as being "*those customary beliefs and values that ethnic groups transmit fairly unchanged from generation to generation*" (Guiso *et al*., 2006). Second culture is unobservable. Guiso *et al*. (2006) identify two principal channels through which it can flow: beliefs and preferences. Following the belief channel, we use differences in immigrants' trust level (i.e., beliefs on trustworthiness) as a reflection of cultural differences. Here, the underlying assumption is that immigrants bring with them some attitudes and beliefs (including trust) that are specific to their home country and that these do not change substantively over an individual's lifetime. An additional difficulty arises from the fact

that the economic and institutional environment can rarely be separated from culture. This often makes causal interpretations difficult. To overcome this problem, in a first step we focus on second generation immigrants who are born and raised in an institutional and economic environment different from that of their parents. The use of this less problematic sample (i.e., second generation) allows us to block the direct impact of the institutional and economic environment of the country of origin on second-generation immigrants' trust level. In a second step, we use an epidemiological approach to assess whether trust of second-generation immigrants is affected by their cultural heritage. This approach consists of comparing information about the outcomes of second-generation immigrants with that of the natives in their country of origin. Intuitively speaking, second generation immigrants face a common environment in the host country (e.g., same institutions), yet they do not share the same culture. In addition, their country of birth is different from that of their parents. Thus, by focusing on second-generation immigrants and using an epidemiological approach we tackle the selection problem as in Fernandez and Fogli (2009). As a result, a positive correlation between the declared trust levels and the trust levels of compatriots in the country of origin will pick up cultural transmission.

This paper is related to two strands of empirical literature with the first analyzing the determinants of trust (for more information, see review of literature) and the second studying the cultural transmission of values, attitudes and beliefs. We follow closely the literature on the cultural transmission and use an epidemiological approach in which we permit for the cultural proxy (i.e. the average level of trust in the country of origin) to vary according to gender, education group and age group. In doing so, we rely on the literature on the determinants of trust and control for individual experiences and characteristics. Unlike most of the literature on intergenerational transmission of culture we focus our attention on Canadian immigrants.[8] To our knowledge this paper is the first paper that assesses the intergenerational transmission of trust in the Canadian context.[9]

[8] So far most of the cultural economics literature has focused on the Unites States.
[9] This is a first step in our work; we are currently looking at the impact of trust on labour market outcomes. We are trying to identify if trust is a channel through which labour market outcomes of Canadian second generation immigrants are affected.

Estimation results show that the average level of trust in the countries of origin of the second-generation immigrants has a strong significant impact on their level of trust. Thus, individual whose country of ancestry displays a high level of trust, tend to have a high level of trust in the host country. This provides evidence that individuals' level of trust is not only explained by their experiences, characteristics, and the environment in which they are living; but also by the culture in their country of ancestry. This means that culture does matter! Our result remains valid when we replace the average level of trust in the country of origin, by country dummies. It is also robust to the omission of individuals whose countries of origin are Great Britain and France or when we exclude individuals from Nordic countries. In addition, we tested whether the validity of this result can be replicated outside the Ethnic Diversity Survey. To this end we use the Canadian General Social Survey of 2003.

The rest of this paper unfolds as follows. In Section 2, we present a brief literature review of the empirical as well as theoretical literature. Section 3 describes the data and provides descriptive statistics. Section 4 presents the empirical strategy and the estimation results. Section 5 provides the robustness checks and finally Section 6 concludes.

1.2 Literature Review

This section provides a review of the empirical evidence on the determinants of trust and the transmission of cultural traits (including trust) as well as an overview of the principal theories on intergenerational transmission of trust.

1.2.1 Empirical Literature

Our paper is related to two lines of research. The determinants of trust are the heart of the first line of research. In this strand, particular attention is given to the role of individual and social characteristics in shaping the trust levels. The presence of higher income disparity and racial heterogeneity seem to have a negative impact on trust levels (Alesina and La Ferrara, 2002). Also, historical variables and events such as bad quality of past institutions and slave trade have similar effects on trust levels (Tabellini, 2010; Nunn and Wantchekon, 2011). While this literature on the determinants of trust shows that individual characteristics and past events can affect a person's level of trust, it does not deal directly with the transmission of trust. This paper contributes to this literature by examining the impact of culture on second-generation immigrants (i.e., descendants of immigrants) level of trust. It is well known that second generation immigrants evolve in an economic and institutional environment that are different from the ones prevailing in their parent's country of origin. Thus, if trust levels in the country of origin affect trust levels of the second-generation immigrants then culture may be considered as one of the determinants of trust.

The second line of research is related to intergenerational transmission of cultural traits. Based on the Census 2006, McDonald and Worswick (2011) investigate whether apprenticeship completion attitude of second-generation immigrants in Canada is influenced that of their parent's generation. The authors find that second-generation men are more likely to have completed an apprenticeship if their fathers' generation of immigrant men have a high probability of apprenticeship completion. Using the German Socio-Economic Panel, Dohmen *et al.* (2011) show that the trust and the risk attitudes of children are positively correlated to that of their parents as well as their local environment. Results from Guiso, Sapienza and

Zingales (2008a) point in the same direction. They show that children's beliefs are positively correlated with that of their parents. Similarly, Uslaner (2008) finds that both culture and social environment influence an individual's trust levels. Yet, he argues that the impact of culture is stronger than the environment in which immigrant's descendants live. While these papers provide valuable information regarding the transmission of culture, they use the ethnicity dummies to measure the impact of culture. The main drawback of using ethnicity dummies approach resides in its failure to explain observed differences between ethnic groups (Fernández and Fogli, 2009). To avoid this problem, a common practice is to assess intergenerational transmission of cultural traits by applying an epidemiological approach as in Giuliano (2007), Fernández and Fogli (2009) and Luttmer and Singhal (2011).[10] This approach consists of verifying if attitudes and beliefs of immigrants' descendants reflect the ones of their parents' country of origin. Giuliano (2007) finds evidence that allows for the conclusion that living arrangement of second-generation immigrants in United States is highly correlated with the one prevailing in the country of their ancestors. In the same spirit, Fernández and Fogli (2009) investigate whether work and fertility behaviours of second-generation American women are influenced by the ones in the country of their ancestry. In their study, they use past values of female labour force participation (LFP) and total fertility rates (TFR) in country of ancestry as cultural proxies. They find that their cultural proxies have a significant impact on work and fertility behaviour of second-generation American women since women whose ancestry is from lower female LFP countries work less and women whose ancestry is from higher TFR countries have more children. Another study by Luttmer and Singhal (2011) tests the first and second-generation immigrants' preferences for redistribution with three rounds of the European Social Survey (ESS). Their results are consistent with the hypothesis that redistributive preference in the country of ancestry influences significantly first and second-generation immigrants. That is, immigrants whose country of origin exhibits higher preference for redistribution tends to show higher preferences for redistribution in the host country.

[10] Based on the epidemiological approach, Algan and Cahuc (2010) find that income per capita differences between developed countries were highly explained by trust.

This paper will follow a similar approach to investigate the presence of intergenerational effect in trust. It contributes to this literature in two ways. First, it focuses on a new cultural trait: trust". Second it provides insights of the intergenerational transmission of culture in the Canadian context.

1.2.2 Theoretical Literature

The earliest theoretical models on cultural transmission relied on evolutionary biology to explain the intergenerational transmission of culture (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985). Their models predict faster assimilation of the minority groups. A well-known problem that comes along with the use of such models is its failure to explain the resilience of cultural traits. To address this issue, Bisin and Verdier (2000, 2001) introduced parental socialization choice in the evolutionary model to explain the persistence of ethnic and religious traits, and the heterogeneity in the distribution of cultural traits. In their model, parental socialization is motivated by the presence of imperfect empathy. Specifically, parents are assumed to care about their children and to evaluate their children's choices using their own preferences as parents. If parents consider their own cultural traits a substitute to the one prevailing, then cultural heterogeneity arises. Conversely, if the parents consider the prevailing cultural traits as a complement then culture homogeneity arises.[11]

A more refined line of theoretical research focused on formalizing the transmission of trust (Tabellini, 2008; Guiso *et al*., 2008a). Following the works of Bisin and Verdier (2001) and Bisin *et al*. (2004), Tabellini (2008) analyzes the evolution of the norms of generalized morality (generalized trust) and focuses on how norms interact with economic incentives.[12] As in Bisin and Verdier (2000, 2001), he uses imperfect empathy and obtains an equilibrium that exhibits strategic complementarity between norms and behaviour. In the presence of strategic complementarity, the payoff from cooperating increases when more people cooperate. This, in turn, leads to a spread of cooperation and makes it is easier for parents to transmit

[11] These cultural transmission models are based on simplifying assumptions and abstract from many mechanisms and social interactions effects.
[12] He neglects the role of reputation in cooperation. In this model, individuals play a one-time prisoner's dilemma game which means that cooperation is the result of internalized values.

it to their children. His model predicts a low level of cooperation and a bad quality of institutions under the limited morality situation (individuals trust only people who are close). Conversely, the generalized morality fosters cooperation and good institutions. Based on this model one should expect the trust level of second-generation immigrants to be higher when their parents come from countries that have reputation for good institutions.

Another line of research focused on overlapping-generations model. Guiso *et al*. (2008a) develop a model that explains intergenerational transmission of culture and long-term persistence of the level of trustworthiness. In their model, there are two types of agents (the trustworthy and the untrustworthy) and two types of environment (honest and dishonest).[13] Parents transmit their priors about the type of environment, in which they are living, to their children. Children, in their turn, update their trust belief through experiences acquired through their interaction in the environment and they update their beliefs and transmit them to their own children. According to the authors, society can be trapped in low trust equilibrium if parents transmit low trust priors to their children. The society can also end up in high trust equilibrium if parents transmit high trust priors to their children. Their model explains how the presence of heterogeneity in second-generation immigrants' trust levels can emerge. It also shows that second-generation immigrants' trust levels are not independent from the trust levels in their country of origin.

[13] These agents are living in two types of environments: the honest environment (dominated by trustworthy agents) and the dishonest environment (dominated by untrustworthy agents).

1.3 Data and Descriptive Statistics

To conduct the main analysis, we use the Ethnic Diversity Survey (EDS) 2002 for Canada, the World Value Survey (WVS) waves of 1995 and 2000 and the Europeans Value Study (EVS) wave of 1999. We then test the validity of the results using the General Social Survey (GSS) 2003. The EDS provides information that permits us to trace second-generation immigrants, their individual characteristics as well as their level of trust and their province of residence. The EDS was jointly initiated by Statistics Canada and the Department of Canadian Heritage. Its objective is to understand how people's backgrounds affect their participation in Canada's social, economic and cultural life and how Canadians of different ethnic origins interpret and report their ethnicity. One of the advantages of using the EDS is that it targets considerable ethnic groups. It contains all necessary information about trust and individual characteristics with all details that are essential to address our research question. The EDS covers 42,476 individuals aged 15 to 99 from 195 ethnic groups of which 15,664 observations are on second-generation immigrants. In addition to detailed information on second-generation immigrants the EDS provides some information on their parents. Using this information, we define second-generation immigrants as individuals who were born in Canada and have at least one parent born outside Canada.[14] We then use the ethnic identity of second-generation immigrants to assign them to their country/region of origin.[15] The final sample contains 12,170 observations,[16] it covers the following 40 countries and regions: Ireland, France, Austria, Belgium, Netherlands, Germany, Switzerland, Finland, Denmark, Norway, Sweden, Hungary, Poland, Romania, Russia, Ukraine, Greece, Italy, Malta, Portugal, Spain, Israel, Armenia, Pakistan, India, China, Philippines, Vietnam, Japan, Korea, United States, Great Britain, Baltic states, Czech & Slovakia, Balkan states (Yugoslavia), Latin Central and South America, Sub-Saharan Africa, Maghreb, Middle East without Israel

[14] Second-generation is defined according to either father country of origin, mother country of origin or both parents' country of origin if they are from the same country or not (see Card *et al.*, 2000; Giuliano, 2007; Fernández and Fogli, 2009; Luttmer and Singhal, 2010).

[15] We use the ethnic identity in order to avoid narrowing our second-generation sample. This helps us to retain all the respondents with at least one immigrant parent regardless if it is the father or the mother. Ethnic identity is more accurate than parent country of birth when it is a question of culture than parent country of birth. Uslaner (2008) uses ethnic identity to attribute the country of origin.

[16] Individuals with missing information on trust, country of origin level of trust, education, mother education, marital status are excluded. We do recognize the nonresponse may lead to sample bias (reduced sample) which in turn may bias our estimates.

and Caribbean.[17] The main control variables are age, education of the respondent (highest degree), gender, religion, mother education, marital status, language, province, ethnic fractionalization index, an indicator variable whether the respondent lives in rural or urban area and whether he is from visible minority.

The dependent variable is self-reported individual level of trust. It is provided by the answer to the following question from EDS: "*Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?*". We transform the answer into dichotomous variables 1 for "*People can be trusted*" and 0 for "*You cannot be too careful in dealing with people*". This type of conversion is a common practice in the literature (see Alesina and La Ferrara, 2002; Leigh, 2006; Giuliano, 2007; Nunn and Wantchekon, 2011; Luttmer and Singhal, 2011).

Country of origin trust levels are from the World Value Survey (WVS) 1995/2000 and the European Values Study (EVS) 1999. The World Value survey (WVS) and the European Values Study (EVS) are collections of cross-national surveys on values, beliefs, preferences, attitudes and motivations of ordinary citizens. They cover 97 countries with 5 waves of surveys. The EVS focuses on European countries only. The WVS and the EVS cover the aforementioned countries and regions in the EDS. The trust question in the WVS, the EVS and the GSS has the same formulation as in the EDS.

The key right hand side variable is average trust level in country of origin. It is measured by the share of people in each country or region who responded that "People can be trusted" in the WVS waves of 1995/2000 and EVS 1999.[18] It is considered as a cultural proxy.[19] We permit the average trust level by country to vary according to gender (male and female), three age groups (15-40, 41-64 and 65+) and two groups of education level (highly educated and lowly educated). We assume that trust levels of second-

[17] Baltic States: Estonia, Latvia and Lithuania.
Czech & Slovakia: Czech Republic and Slovakia.
Balkan states (Yugoslavia): Kosovo, Croatia, Macedonia, Serbia, Slovenia and Bosnia.
Latin, Central and South America: Argentina, Belize, Bolivia, Brasilia, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Salvador, Uruguay, Venezuela.
Sub-Saharan Africa: Ethiopia, Angola, Burundi, Cameroon, Democratic Republic of the Congo, Republic of the Congo, Eritrea, Ghana, Guinea, Kenya, Ivory Coast, Mali, Nigeria, Rwanda, Senegal, Sierra Leone, Somali, South Africa, Sudan, Tanzania, Togo, Uganda and Zimbabwe.
Maghreb: Algeria, Morocco, Tunisia, Libya.
Middle East without Israel: Egypt, Iraq, Lebanon, Palestine, Saudi Arabia, Syria, Yemen, Jordan, Iran and Turkey.
Caribbean: Antigua, Bahamas, Barbados, Bermuda, Cuba**,** Dominican Republic**,** Grenada, Guyana, Haiti, Jamaica, Federation of Saint Kitts and Nevis, Martinique, Puerto Rico, Saint Lucia, Trinidad and Tobago, Saint Vincent and the Grenadines, West Indies.
[18] The choice of those waves is dictated by data availability.
[19] We use the EVS for the European countries and the WVS for the rest of the world.

generation immigrants should be on average similar to the one we measure in their country of origin have they been born and living there. Usually, average trust levels in country of origin embody different effects. It includes the impact of economic, institutional and cultural environment on trust levels of those who are born and are living there. As for second-generation immigrants, only culture can have an impact on their trust level given that they are living in different economic and institutional environment (Fernández and Fogli, 2009).

We also use the Canadian Census of 2001 to construct the ethnic fractionalization index. It measures the probability that two randomly selected individuals in a census metropolitan area (CMA) are from different ethnic group. It is computed as follows:

$$Fract_j = 1 - \sum_i^N s_{ij}^2 , \quad (1.1)$$

where *j* represents a CMA or census agglomeration (CA) and s_{ij} is the share of ethnic group *i* living in the CMA or CA *j*. We compute the ethnic fractionalization index of the 122 CMAs and CAs with 206 ethnic groups of the census. Fractionalization (fragmentation) index is standard in the literature on the determinants of trust (Alesina and La Ferrara, 2002; Leigh, 2006; Nunn and Wantchekon, 2011). Alesina and La Ferrara (2002) found that racial fractionalization index negatively affect the level of trust while for Leigh (2006) it was the linguistic fractionalization index.

Before turning to the descriptive statistics, we will provide a brief overview on the evolution of the distribution and structure of immigration in Canada. In the 1960's the removal of the regulatory and legislative criteria that used to discriminate against potential immigrants on the basis of race and ethnicity have altered the source of the country's immigration. The immigration from North-West Europe declined visibly while immigration from South-West Europe declined modestly and immigration from Asia increased substantially. The share of immigrants from Europe decreased from 61.6% in 1971 to 16.1% in 2006, while the share of immigrants from Asia (including the Middle East) increased from 12.1% in 1971 to 58.3% in 2006. A non-negligible increase is observed for immigration from Central and South America and the Caribbean (from 8.9% in 2001 to 10.8% in 2006) and Africa (from 8.3% in 2001 to 10.6% in 2006).

Whilst, these immigrants and their descendants face the same economic and institutional environment, the literature shows that there exists a large difference in their economic performance (Heath and Cheung, 2007), in the attitudes and beliefs among those groups and, between them and the natives (long generation born Canadian) (Kazemipur, 2009; Almond *et al*., 2013). Table 1.1 reports the summary statistics by country. It lists the number of individuals by country and region, and proportions of individual who trust by country and region. For example, 2960 individuals have Great Britain as their ancestry country of origin and 63.3% of them trust. The proportion of individuals who trust by country varies from 39.22% in Caribbean region to 67.79% in Baltic States. The number of individuals by country of origin also varies from 30 in Malta to 2960 in Great Britain. Observations in this table are not a representative sample of the population of the country of origin. This is not an issue for the purpose of this paper, as our objective is to focus on this particular subsample of the population: second-generation immigrants. Table 1.2 reports the summary statistics of the characteristics of the sample used. There are 55.12% of respondents who trust, males constitutes 46.44% of our sample, 48.15% of individuals are married, 86.69% of respondents live in urban areas, and 48.75% live in Ontario province.

1.4 Empirical Strategy and Results

1.4.1 Empirical Strategy

In this study, we assess whether culture affects second-generation immigrants' level of trust. One can achieve this objective either by controlling for ancestry (i.e., countries dummies approach), or by finding a proxy for culture (i.e., epidemiological approach). The epidemiological approach consists of verifying if the attitudes and beliefs of descendants of immigrants reflect the ones of their parents' country of origin. The key identifying condition in this type of approach relies on the fact that second-generation immigrants face the same market and institutional environment as everybody else in the host country, yet have different cultural background. The countries dummies approach consists of controlling for ancestry using a country dummy variable. In this paper, we rely primarily on the epidemiological approach as it provides more insights about the reason for which we observe cultural transmission and allows us to depict cultural transmission through a well-defined channel (i.e., trust in the country of origin). We also, explore the country dummies approach to cross validate the results obtained in the epidemiological approach.

As mentioned earlier the epidemiological approach was widely used in the cultural economics literature. It has been used to analyse female labour force participation and fertility (Fernández and Fogli, 2009), redistribution (Luttmer and Singhal, 2011), growth, trust and social capital (Tabellini, 2007; Algan and Cahuc, 2010) as well as living arrangements (Giuliano, 2007). Yet, the use of this approach does not come without a well-known series of setbacks. First, immigrants are not a representative sample of their country of ancestry's population; they may differ from the average population in the country of origin. More specifically, they might be less attached to their ancestry's culture than people who have not emigrated.[20] In addition to that, immigrants are *de facto* exposed to a culture that is different from the one prevailing in their country of origin. This is why the influence of the environment in the host country may weaken the impact of their culture. Also, it is possible to argue that immigrants might have been exposed to some difficulties (e.g., difficult market conditions) that forced them on a fast-track assimilation. In this

[20] The reverse may also hold, i.e. they might be more attached to their ancestry's culture.

case, the influence of the culture of their country of origin might not resist very long. The occurrence of one or all of these circumstances might bias the estimate of the cultural variable towards finding the estimate to be statistically insignificant. Also, it is important to know that while cultural assimilation may remain one of the largest concerns in this type of approach, it only biases the estimates downward (i.e., to a lower impact of culture). In this case, our estimate can be interpreted as a lower bound for the impact of intergenerational transmission of trust.

To isolate the impact of cultural attributes (trust) of the country of ancestry we estimate the following reduced form model:

$$C_{ipk} = \gamma_0 + \gamma_1 C_k + \gamma_2 X_{ipk} + F_p + v_{ipk}\,, \qquad (1.2)$$

where C_{ipk} denotes the cultural variable (trust) of individual *i* living in province p with *k* as country of origin (ancestor country), C_k is the average level of trust in the country of origin. It varies according to gender (male and female), to three age groups (15-40, 41-64 and 65+) and two groups of education level (highly educated and lowly educated). It embodies the economic, institutional and cultural elements in the parents' country of birth. The vector of individual characteristics is denoted by X_{ipk} and includes all the characteristics that were presented in the descriptive statistics, F_p is a dummy variable that controls for provinces fixed effects, the error term is denoted by v_{ipk}. Our main assumption here is that culture changes slowly over time. This is why the proxy for culture, which is our key variable C_k, will help us to depict the component in the individual's trust level that is due to culture after controlling for individual attributes. Thus, the parameter γ_1 will measure the impact of trust inherited from parents only.

The use of subjective measures (i.e. based on self-report), raises controversies among economists. It is argued that subjective data may be biased or noisy and that any regression with subjective data in both sides of the equation may lead to endogeneity when both sides are at the individual level (Anand *et al.*, 2008). Also, subjective measures may be sensitive to questions ordering, wording, response scales and, the social desirability and instability attitudes of the respondents (Bertrand and Mullainathan, 2001). In addition, answers to the subjective questions may depend on the personality and the mood of respondents

and, conditions (day or time) under which respondents are interviewed (Ravallion, 2012). All this may lead to measurement error. In regressions analysis, subjective variables are acceptable as independent variables if the measurement error is small. Although, they are not good as dependent variable since the measurement error may be correlated with the control variables (Bertrand and Mullainathan, 2001).

In this paper, the dependent subjective self-reported variable is at the individual level and the independent subjective self-reported variable is at the country of origin level. In addition, the control variables are not subjective self-reported variables. This being the case, it follows that individuals who respond the dependent self-reported variable and those who respond to the independent self-reported variable are not the same. This is why it is unlikely that endogeneity issues (as pointed by Anand *et al.*, 2008) or correlated measurement errors (as pointed by Bertrand and Mullainathan, 2001) are present in this context. This being said, the biases of the subjective measures as dependent variables are hardly avoidable (Ravallion, 2012). Notwithstanding these aforementioned potential problems, trust was widely investigated by empirical economists. As for the wording of the trust question, it has been used in the survey since 1972 (United States GSS) and the choice of responses gives more freedom to the respondents since he /she can answers by choosing "*People can be trusted*", "*You cannot be too careful in dealing with people*", "*Refused*" or "*Don't know*".

Given that the dependant variable is binary, we estimate equation (1.2) using a standard probit regression with province fixed effects. All the computed standard errors are robust and corrected for clustering in the country of origin to account for correlations between the error terms.

1.4.2 Estimation Results

Estimation results presented in Table 1.3 report marginal effects for estimates of Eq.1.2. In column (1) we report the regression estimates without any controls. In column (2) we control for provinces fixed effects. From column (3) to (9) we add individual characteristics gradually. Looking at Table 1.3, one can notice that the sign of the marginal effect is within the expected lines. Without any control variables, a one unit increase in the average trust in the country of origin increases the probability of trusting by 28.8 percentage

points. Otherwise, if the proportion of people who trust in the country of origin increases by 1 percent, the probability that the individual trust goes up by 0.288 percent. When controls are introduced the marginal effects vary between 11.2 percentage points to 26.5 percentage points but remain statistically significant at a 1% level. This means that second-generation immigrants inherited some level of trust from their parents' country of origin. It thus indicates that there is a transmission of trust from parents to children. This result is consistent with findings in many related studies in the cultural economics literature. Tabellini (2007), for instance, uses trust to measure immigrants' attitudes towards cooperation. He finds that an increase in the average trust in the country of origin increases significantly the probability of trust in the host country (i.e., the United States).

When we control for province fixed effects, we find that being in any other province than Québec increases the probability of trust. Yet, this does not change the magnitude of the parameter or its significance. As expected, the level of trust increases with age but at a declining rate. This is consistent with results in other studies (see Alesina and La Ferrara, 2002; Leigh, 2006; Guiso *et al*., 2008a). Gender seems to have a significant impact on trust; being a male increases the probability of trusting. This is consistent with the empirical literature as well as the experimental literature on trust (see Alseina and Ferrara, 2002; Altmann *et al*., 2008 among others). Living in an urban area decreases the probability of trust. One can interpret this result as reflecting the impact of the presence of asymmetrical information in large areas compared to small area.

To account for the possibility that second-generation immigrant's level of trust may be explained by parents' human capital instead of culture, we control for mother's education. We find that having a mother with low education level decreases significantly the probability of trusting compared to having a highly educated mother. Also, being a visible minority reduces the probability of trusting by 6.01 percentage point when all controls are taken into account. As education level plays an important role in shaping trust, we introduce controls for the impact of respondents' level of education on trust by using the education level dummies. We find that not having a university degree decreases the probability of trusting. In other terms, having a university degree increases the probability of trusting. This result is in line with

our expectation and is consistent with Alesina and La Ferrara (2002) and Leigh (2006). In addition to education, family and individual characteristic, the literature on cultural economics has emphasized the importance of religious beliefs on trust. It is argued that the hierarchical nature of the Catholic Church discourages the formation of trust (Putman, 1993). This argument has been extended to all hierarchical religions (Catholicism, Orthodox Christianity and Islam). To control for this possibility we include dummies for hierarchical religions and non-hierarchical religions (no religion affiliation is omitted). Results show that having a hierarchical religious affiliation decreases the probability of trust when compared to individuals with no religious affiliation 5.12%. This result is consistent with that of La Porta *et al*. (1997) and Berggren and Jordahl (2006) who find that hierarchical religions have a negative impact on trust.

1.5 Robustness Checks

In this section we test for the robustness of results obtained in the previous section in three different ways. First we test the sensitivity of the results to the exclusion of certain countries and by using the third and more generation. We also run a regression using the countries dummy approach to seek confirmation regarding the validity of the results obtained by using the epidemiological approach. Finally, to test if the results are validated in another survey, we run the epidemiological approach using the GSS.

1.5.1 Excluding certain Observations and the Third and Higher Generation Immigrants

At this step of our robustness checks we exclude individuals from specific ancestry and examine how marginal effects of trust of ancestry changes. Results are reported in Table 1.5. In column (1), we exclude Great Britain and France. This is to test whether these large sized groups drive the results obtained earlier.[21] In column (2), we exclude Nordic countries (Sweden, Norway, Finland and Denmark). This is to test whether high trusting countries might be driving the results. In column (3) we exclude Great Britain, France and Nordic Countries. In column (4) we exclude Germany as well as the same countries as in column (3).

[21] These two groups constitute the main source of the Canadian immigration.

The last two specifications are to test whether removing immigrants from west European countries are driving our results. The estimations obtained show that the significance and the sign of the impact of trust in the country of ancestry are robust to all these specifications. In addition to that, we account for the possibility that looking at second-generation immigrants may not be considered as a sufficient. To this end, we limit our sample to immigrants of third and higher generation. The results are reported in column-5. Again, the trust parameter remains consistent with the results previously obtained but is significant only at the 5% level.

1.5.2 Country Dummies Approach

The country dummy approach is an alternative way of estimating the transmission of trust from country of ancestry to the immigrants present in the host country. This approach has been used to analyse the impact of culture on fertility, savings, self-employment rate, wage gap, living arrangement and trust (Blau, 1992; Carroll *et al.*, 1994; Fairlie and Meyer, 1996; Antecol, 2000; Giuliano, 2007; Uslaner, 2008)

We estimate the following model:

$$C_{ipk} = \gamma_0 + \sum_k \beta_k D_{ik} + \gamma_2 X_{ipk} + F_p + v_{ipk}, \qquad (1.3)$$

where D_{ik} is equal to 1 if *i* belongs to the country *k* and is zero otherwise and β_k is a country-specific cultural effect. As in the epidemiological model the model is estimated using a standard probit with country fixed effects and all the standard errors are corrected for clustering at the country of origin level.

The estimation results are reported in Table 1.4 where the country of reference is Sweden.[22] As in the case of the epidemiological approach we add the controls gradually. In column (9) of Table 1.4, which contains all of our main control variables, the estimated β_k coefficients are statistically significant at the 1% level for all the countries except Netherland, Norway, Russia, Vietnam and Maghreb (β_k is not statistically significant); Finland, Hungary and Czech & Slovakia (β_k is statistically significant at 10% level) and, Poland, Armenia and Great Britain (β_k is statistically significant at 5% level). Respondents

[22] The use of Sweden as a reference is standard practice in the literature on trust (see Algan and Cahuc, 2010).

whose country of origin is India tend to have a low probability of trust compared to respondents whose country of origin is Sweden. Having India as a country of origin decreases the probability to trust by 13.2 percentage points compared to having Sweden as a country of origin. Conversely, having Japan as a country of origin increases the probability to trust by 8.29 percentage points compared to having Sweden as a country of origin. This allows us to conclude that trust of second-generation immigrants is affected by their country of ancestry. While this approach fails to provide further information regarding whether there is intergenerational transmission of trust, it does provide rough evidence that is consistent with this hypothesis.

1.5.3 Epidemiological Approach Using GSS (2003)

What if these results are specific to the data used? To test the validity of the results obtained from the epidemiological approach further, we estimate equation (1.2) using the General Social Survey of 2003. The objectives of the GSS are "to monitor changes in the living conditions and well-being of Canadians over time and to provide information on specific social policy issues of current or emerging interest" (Statistics Canada). This cycle of 2003 collects data on social engagement, social participation, civic participation, trust and reciprocity. We have chosen this cycle because it covers most of our control variables. This cycle covers 24,951 individuals aged 15 to 98 from 15 ethnics groups of which 4,293 observations are on second-generation immigrants. After considering all the respondents that answer to our main control variables, the final sample contains 2,534 observations and covers the following 12 countries and region: Ireland, France, Netherlands, Germany, Poland, Ukraine, Italy, Portugal, Israel, China, Great Britain and South Asian (East Indian, Pakistan, Sri Lanka, etc.). The principal control variables are age, education of the respondent (highest degree), gender, religion, mother education, marital status, language, province, an indicator variable whether the respondent lives in rural or urban area and whether he is from visible minority. Estimation results using the GSS (Table 1.6) provide evidence that the intergenerational transmission of trust is validated in more than one survey.

1.6 Conclusion

This paper complements the empirical literature on the determinants of trust as well as the literature on the importance of culture in explaining behaviours, attitudes and beliefs of descendant of immigrants. Its objective is to seek evidence on the presence of intergenerational transmission of trust among second-generation immigrants in Canada. To this end, we rely on the literature in cultural economics and use the epidemiological approach. Our results indicate that second-generation immigrants' level of trust increases significantly with average levels of trust of their parents' country of origin. To evaluate the stability of these results, we perform some robustness checks. We find that our results remain robust to omitting certain key countries (e.g., Great Britain and France, the Nordic countries), to additional control (income, degree of ethnicity and proportion of friends with the same ethnicity) and to the use of third and higher generation of immigrants. Finally we validate our results using a different data set: the GSS 2003.

As trust is one of the many dimensions of culture, one can interpret our result as reflecting the transmission of a specific cultural trait. This means that culture matters in explaining the heterogeneity trust levels among second-generation immigrants in Canada. We believe that understanding how the culture in the country of origin affects trust is crucial from a policy perspective as it increases the quality of policies (Putman, 1993). Also, in the presence of more information about the dimension in which acculturation succeeds or fails, policy makers can make well-informed decision regarding their integration policies (acculturation) when deemed important. This, in turn, decreases transaction costs and enhances economic efficiency (Knack and Kefeer, 1997) as fewer resources are spent on trust related issues (Fehr *et al.*, 1997). In addition, by adopting policies that help improving the trust level of immigrants, one can increase cohesion in the society and thus ameliorate cooperation and good institution.

This paper can be extended in many ways. First, one can assess the impact of trust on labour market outcomes such as labour market participation and earnings. This will provide a more complete picture of the economic importance of trust in the Canadian labour market. In the same perspective, one can also

evaluate the impact of trust on education. A second natural extension to this paper would be to assess the horizontal (peer-to-peer) transmission to trust by incorporating a social interaction component to the model.

Appendix 1: Tables

Table 1.1: Country Summary Statistics

Country	Observations	Mean value of trust
Japanese	120	0.6779
Baltic States	70	0.6461
Swedish	100	0.6421
Norwegian	130	0.639
Finnish	60	0.6379
British	2960	0.633
Balkan States	160	0.6178
Polish	290	0.613
Dutch	590	0.6122
Russian	140	0.6102
Czech & Slovakia	90	0.6046
German	900	0.6008
Danish	100	0.594
Hungarian	160	0.5889
Austrian	90	0.5824
American	160	0.5723
Irish	570	0.5671
Chinese	740	0.5576
Ukrainian	370	0.5471
Israeli	110	0.5428
Belgian	80	0.5365
Swiss	50	0.5185
French	510	0.5136
Vietnamese	50	0.4905
Maghreb	40	0.4864
Portuguese	180	0.467
Armenian	50	0.4666
Italian	970	0.4653
Maltese	30	0.4516
Filipino	220	0.447
Sub-Saharan Africa	160	0.4444
Greek	140	0.4316
Latin, Central, South America	130	0.4285
India	550	0.4283
Pakistani	50	0.4255
Middle East	270	0.4135
Korean	50	0.4117
Romanian	40	0.4047
Spanish	70	0.397
Caribbean	620	0.3922
Total	12170	0.5512

Table 1.2: Descriptive Statistics

Variable	Observation	Mean	Std. Dev.
Trust	12170	0.5512	0.4973
Country of origin level of trust	12170	0.3956	0.1864
Age	12170	38.8192	18.5237
Male	12170	0.4644	0.4987
Marital status	12170	0.4815	0.4996
Urban	12170	0.8669	0.3396
Visible minority	12170	0.246	0.4307
Mother degree:	12170		
Degree, diploma or certificate from college or university		0.2752	0.4466
Some college or university		0.0819	0.2743
High school diploma		0.2666	0.4422
Less than a high school diploma		0.3761	0.4844
Degree:	12170		
Degree, diploma or certificate from college or university		0.4169	0.493
Some college or university		0.1689	0.3746
High school diploma		0.2069	0.4051
Less than a high school diploma		0.2071	0.4053
Religion:	12170		
No religious affiliation		0.2063	0.4047
Hierarchical religions		0.3667	0.4819
Non-hierarchical religions		0.4269	0.4946
Language	12170	0.1381	0.345
Ethnic Fractionalization index	12170	0.8677	0.0786
Province:	12170		
Quebec		0.1148	0.3188
Atlantic		0.0186	0.1351
Ontario		0.4875	0.4998
Manitoba		0.0392	0.1942
Saskatchewan		0.0283	0.1658
Alberta		0.1258	0.3317
British-Colombia		0.1855	0.3887

Table 1.3: Effect of Culture on Second-generation Immigrants Level of Trust

	Dependent variable : Trust								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Country of origin level of trust	0.288***	0.265***	0.213***	0.206***	0.205***	0.135***	0.133***	0.106***	0.112***
	(0.069)	(0.067)	(0.038)	(0.029)	(0.029)	(0.032)	(0.033)	(0.037)	(0.039)
Quebec (Omitted)									
Atlantic		0.122***	0.0912***	0.0894***	0.0888***	0.0981***	0.110***	0.0952***	0.0909***
		(0.024)	(0.023)	(0.024)	(0.024)	(0.024)	(0.027)	(0.027)	(0.027)
Ontario		0.123***	0.119***	0.118***	0.117***	0.125***	0.160***	0.146***	0.142***
		(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.024)	(0.027)	(0.028)
Manitoba		0.178***	0.167***	0.166***	0.165***	0.172***	0.204***	0.189***	0.188***
		(0.025)	(0.025)	(0.025)	(0.025)	(0.024)	(0.032)	(0.034)	(0.034)
Saskatchewan		0.156***	0.120***	0.119***	0.118***	0.130***	0.160***	0.145***	0.144***
		(0.031)	(0.030)	(0.031)	(0.031)	(0.030)	(0.040)	(0.041)	(0.042)
Alberta		0.180***	0.167***	0.167***	0.166***	0.178***	0.210***	0.194***	0.191***
		(0.021)	(0.020)	(0.021)	(0.021)	(0.020)	(0.029)	(0.031)	(0.031)
British-Colombia		0.147***	0.139***	0.142***	0.141***	0.154***	0.187***	0.165***	0.162***
		(0.023)	(0.019)	(0.018)	(0.018)	(0.018)	(0.024)	(0.025)	(0.025)
Age			0.0109***	0.00916***	0.00778***	0.00413***	0.00411***	0.00405***	0.00377**
			(0.0018)	(0.0018)	(0.0018)	(0.0015)	(0.0015)	(0.0015)	(0.0015)
Age2			-0.0000839***	-0.0000705***	-0.0000578***	-0.0000202	-0.0000204	-0.0000215	-0.0000191
			(0.000020)	(0.000020)	(0.000020)	(0.000016)	(0.000016)	(0.000016)	(0.000016)
Sex			0.0233**	0.0237**	0.0231**	0.0260**	0.0256**	0.0252**	0.0252**
			(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)
Urban			-0.0317***	-0.0235**	-0.0217*	-0.0311***	-0.0242**	-0.0206*	-0.0195*
			(0.010)	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)
Mother:Degree, diploma or certificate from college or university (Omitted)									
Some college or university			-0.0328	-0.0357	-0.0352	-0.0299	-0.0301	-0.0295	-0.0290
			(0.022)	(0.023)	(0.022)	(0.022)	(0.021)	(0.021)	(0.021)
High school diploma			-0.0375***	-0.0418***	-0.0421***	-0.0321***	-0.0315***	-0.0311***	-0.0288***
			(0.0092)	(0.0085)	(0.0084)	(0.0085)	(0.0086)	(0.0087)	(0.0089)
Less than a high school diploma			-0.0922***	-0.0959***	-0.0963***	-0.0789***	-0.0784***	-0.0727***	-0.0642***
			(0.012)	(0.013)	(0.013)	(0.014)	(0.014)	(0.011)	(0.011)
Visible minority				-0.0582***	-0.0570***	-0.0636***	-0.0607***	-0.0664***	-0.0601***
				(0.018)	(0.018)	(0.018)	(0.019)	(0.016)	(0.016)
Marital status					0.0216*	0.0220*	0.0209*	0.0223*	0.0225*
					(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Degree, diploma or certificate from college or university(Omitted)									
Some college or university						-0.0443***	-0.0445***	-0.0460***	-0.0471***
						(0.011)	(0.011)	(0.011)	(0.012)
High school diploma						-0.0831***	-0.0840***	-0.0894***	-0.0902***
						(0.016)	(0.017)	(0.017)	(0.017)
Less than a high school diploma						-0.0916***	-0.0930***	-0.0981***	-0.0984***
						(0.022)	(0.022)	(0.023)	(0.023)
Ethnic Fractionalization							-0.201*	-0.186*	-0.167
							(0.11)	(0.11)	(0.11)
No religious affiliation (Omitted)									
Hierarchical religions								-0.0554***	-0.0512**
								(0.021)	(0.021)
Non-hierarchical religions								-0.0116	-0.0114
								(0.015)	(0.015)
Language									-0.0453***
									(0.017)
Number of observations	12170	12170	12170	12170	12170	12170	12170	12170	12170
Number of clusters	40	40	40	40	40	40	40	40	40
Pseudo R2	0.0084	0.016	0.0271	0.0285	0.0287	0.0319	0.0322	0.0336	0.0342

Notes: Robust standard errors adjusted for clustering by country of origin.
*** p<0.01, ** p<0.05, * p<0.1

Table 1.4: Country Dummy Estimates

	Dependent variable : Trust								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Swedish (omitted)									
Ireland	-0.0775***	-0.0582***	-0.0471***	-0.0471***	-0.0492***	-0.0469***	-0.0464***	-0.0393***	-0.0400***
	(0)	(0.0038)	(0.0046)	(0.0046)	(0.0045)	(0.0046)	(0.0047)	(0.0056)	(0.0054)
France	-0.131***	-0.0702***	-0.0520***	-0.0520***	-0.0536***	-0.0542***	-0.0558***	-0.0430***	-0.0440***
	(0)	(0.0095)	(0.0096)	(0.0096)	(0.0094)	(0.0091)	(0.0091)	(0.011)	(0.011)
Austria	-0.0621***	-0.0527***	-0.0402***	-0.0402***	-0.0422***	-0.0512***	-0.0498***	-0.0395***	-0.0365***
	(0)	(0.0019)	(0.0048)	(0.0048)	(0.0044)	(0.0044)	(0.0047)	(0.0068)	(0.0071)
Belgium	-0.108***	-0.0568***	-0.0400***	-0.0400***	-0.0416***	-0.0419***	-0.0450***	-0.0293**	-0.0306**
	(0)	(0.0078)	(0.0088)	(0.0088)	(0.0086)	(0.0086)	(0.0085)	(0.013)	(0.012)
Netherland	-0.0313***	-0.0213***	-0.00391	-0.00391	-0.00769	-0.0111*	-0.0120*	-0.00968	-0.00841
	(0)	(0.0032)	(0.0062)	(0.0062)	(0.0060)	(0.0065)	(0.0062)	(0.0068)	(0.0069)
Germany	-0.0431***	-0.0365***	-0.0186***	-0.0186***	-0.0206***	-0.0225***	-0.0225***	-0.0198***	-0.0166***
	(0)	(0.0018)	(0.0049)	(0.0049)	(0.0045)	(0.0046)	(0.0046)	(0.0050)	(0.0053)
Switzerland	-0.126***	-0.0881***	-0.0623***	-0.0623***	-0.0635***	-0.0666***	-0.0667***	-0.0646***	-0.0570***
	(0)	(0.0061)	(0.0082)	(0.0082)	(0.0080)	(0.0077)	(0.0077)	(0.0077)	(0.0085)
Finland	-0.00442***	0.0106***	0.0166***	0.0166***	0.0138***	0.00907	0.00811	0.00656	0.0151*
	(0)	(0.0036)	(0.0050)	(0.0050)	(0.0051)	(0.0066)	(0.0062)	(0.0070)	(0.0077)
Denmark	-0.0502***	-0.0459***	-0.0350***	-0.0350***	-0.0390***	-0.0417***	-0.0419***	-0.0430***	-0.0424***
	(0)	(0.0023)	(0.0048)	(0.0048)	(0.0050)	(0.0054)	(0.0053)	(0.0051)	(0.0053)
Norway	-0.00318***	-0.00540**	-0.00147	-0.00147	-0.00341	0.00358	0.00327	0.00409	0.00546
	(0)	(0.0023)	(0.0032)	(0.0032)	(0.0030)	(0.0035)	(0.0035)	(0.0034)	(0.0035)
Hungary	-0.0554***	-0.0393***	-0.0275***	-0.0275***	-0.0289***	-0.0314***	-0.0308***	-0.0209**	-0.0153*
	(0)	(0.0037)	(0.0059)	(0.0059)	(0.0058)	(0.0060)	(0.0060)	(0.0083)	(0.0088)
Poland	-0.0305***	-0.0124***	0.00271	0.00271	0.000884	0.00202	0.00433	0.0181*	0.0265**
	(0)	(0.0037)	(0.0058)	(0.0058)	(0.0057)	(0.0061)	(0.0064)	(0.0100)	(0.011)
Romania	-0.234***	-0.197***	-0.180***	-0.180***	-0.180***	-0.183***	-0.180***	-0.169***	-0.165***
	(0)	(0.0067)	(0.0077)	(0.0077)	(0.0076)	(0.0076)	(0.0076)	(0.0096)	(0.0099)
Russia	-0.0334***	-0.0206***	-0.00898**	-0.00898**	-0.0100**	-0.00821*	-0.00748*	0.00184	0.00941
	(0)	(0.0021)	(0.0041)	(0.0041)	(0.0039)	(0.0042)	(0.0043)	(0.0066)	(0.0078)
Ukraine	-0.0977***	-0.0965***	-0.0812***	-0.0812***	-0.0820***	-0.0783***	-0.0771***	-0.0635***	-0.0490***
	(0)	(0.0023)	(0.0041)	(0.0041)	(0.0040)	(0.0043)	(0.0042)	(0.0090)	(0.012)
Greece	-0.210***	-0.162***	-0.114***	-0.114***	-0.114***	-0.133***	-0.129***	-0.111***	-0.0894***
	(0)	(0.0075)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.016)	(0.019)
Italy	-0.178***	-0.139***	-0.0965***	-0.0965***	-0.0993***	-0.110***	-0.107***	-0.0880***	-0.0756***
	(0)	(0.0064)	(0.011)	(0.011)	(0.010)	(0.010)	(0.011)	(0.015)	(0.017)
Malta	-0.191***	-0.171***	-0.123***	-0.123***	-0.125***	-0.150***	-0.147***	-0.131***	-0.130***
	(0)	(0.0058)	(0.011)	(0.011)	(0.011)	(0.010)	(0.011)	(0.014)	(0.013)
Portugal	-0.176***	-0.144***	-0.0777***	-0.0777***	-0.0797***	-0.0921***	-0.0890***	-0.0714***	-0.0555***
	(0)	(0.0056)	(0.013)	(0.013)	(0.012)	(0.012)	(0.013)	(0.016)	(0.018)
Spain	-0.242***	-0.189***	-0.144***	-0.144***	-0.143***	-0.154***	-0.153***	-0.140***	-0.130***
	(0)	(0.0082)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.014)
Israel	-0.102***	-0.0601***	-0.0550***	-0.0550***	-0.0572***	-0.0680***	-0.0633***	-0.0449***	-0.0436***
	(0)	(0.0067)	(0.0073)	(0.0073)	(0.0072)	(0.0079)	(0.0094)	(0.013)	(0.013)

Table 1.4: Country Dummy Estimates (Continued)

	Dependent variable : Trust							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Quebec (Omitted)									
Atlantic	0.0747***	0.0665***	0.0665***	0.0657***	0.0731***	0.0836***	0.0782***	0.0762***
	(0.022)	(0.023)	(0.023)	(0.023)	(0.023)	(0.027)	-0.027	(0.027)
Ontario	0.104***	0.105***	0.105***	0.104***	0.111***	0.139***	0.134***	0.131***
	(0.018)	(0.017)	(0.017)	(0.017)	(0.017)	(0.029)	(0.029)	(0.030)
Manitoba	0.143***	0.150***	0.150***	0.148***	0.156***	0.183***	0.177***	0.176***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.035)	(0.036)	(0.036)
Saskatchewan	0.105***	0.102***	0.102***	0.100***	0.112***	0.137***	0.133***	0.132***
	(0.031)	(0.033)	(0.033)	(0.033)	(0.033)	(0.042)	(0.043)	(0.043)
Alberta	0.151***	0.151***	0.151***	0.150***	0.160***	0.187***	0.181***	0.179***
	(0.023)	(0.022)	(0.022)	(0.022)	(0.021)	(0.031)	(0.031)	(0.032)
British-Colombia	0.124***	0.123***	0.123***	0.123***	0.132***	0.159***	0.151***	0.149***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.018)	(0.024)	(0.025)	(0.025)
Age		0.0110***	0.0110***	0.00953***	0.00368**	0.00369**	0.00368**	0.00358**
		(0.0018)	(0.0018)	(0.0017)	(0.0016)	(0.0016)	(0.0016)	(0.0016)
Age2		-0.0000964***	-0.0000964***	-0.0000831***	-0.0000226	-0.0000229	-0.0000232	-0.0000221
		(0.000018)	(0.000018)	(0.000017)	(0.000017)	(0.000017)	(0.000017)	(0.000017)
Sex		0.0242**	0.0242**	0.0236**	0.0269***	0.0265***	0.0262***	0.0258***
		(0.0098)	(0.0098)	(0.0099)	(0.0099)	(0.0100)	(0.0099)	(0.0099)
Urban		-0.0184*	-0.0184*	-0.0166	-0.0266**	-0.0213*	-0.0200*	-0.0195*
		(0.010)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Mother: Degree, diploma or certificate from college or university (Omitted)								
Some college or university		-0.0370	-0.0370	-0.0365	-0.0301	-0.0304	-0.0305	-0.0303
		(0.023)	(0.023)	(0.023)	(0.022)	(0.022)	(0.022)	(0.022)
High school diploma		-0.0448***	-0.0448***	-0.0451***	-0.0318***	-0.0316***	-0.0317***	-0.0307***
		(0.0093)	(0.0093)	(0.0092)	(0.0098)	(0.0098)	(0.0099)	(0.0098)
Less than a high school diploma		-0.0908***	-0.0908***	-0.0912***	-0.0660***	-0.0662***	-0.0656***	-0.0603***
		(0.0093)	(0.0093)	(0.0095)	(0.011)	(0.011)	(0.010)	(0.010)
Marital status				0.0225*	0.0229*	0.0220*	0.0223*	0.0226*
				(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Degree, diploma or certificate from college or university(Omitted)								
Some college or university					-0.0475***	-0.0476***	-0.0479***	-0.0486***
					(0.012)	(0.012)	(0.012)	(0.012)
High school diploma					-0.108***	-0.108***	-0.108***	-0.109***
					(0.014)	(0.014)	(0.014)	(0.014)
Less than a high school diploma					-0.114***	-0.115***	-0.115***	-0.116***
					(0.020)	(0.020)	(0.020)	(0.020)
Ethnic Fractionalization						-0.166	-0.163	-0.154
						(0.11)	(0.11)	(0.11)

Table 1.4: Country Dummy Estimates (Continued)

	Dependent variable : Trust								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
No religious affiliation (Omitted)									
Hierarchical religions								-0.0297	-0.0282
								(0.019)	(0.019)
Non-hierarchical religions								0.0000278	0.00084
								(0.013)	(0.013)
Language									-0.0463***
									(0.016)
Number of observations	12170	12170	12170	12170	12170	12170	12170	12170	12170
Number of clusters	40	40	40	40	40	40	40	40	40
Pseudo R2	0.0203	0.0247	0.0314	0.0314	0.0316	0.0375	0.0377	0.0381	0.0386

Notes: Robust standard errors adjusted for clustering by birth country of origin.
*** p<0.01, ** p<0.05, * p<0.1

Table 1.5: Robustness Check

	Dependent variable : Trust				
	(1)	(2)	(3)	(4)	(5)
Country of origin level of trust	0.107**	0.123***	0.112**	0.115**	0.117**
	(0.043)	(0.042)	(0.045)	(0.046)	(0.046)
Quebec (Omitted)					
Atlantic	0.120**	0.0759***	0.0859*	0.0973*	0.158***
	(0.052)	(0.024)	(0.050)	(0.056)	(0.019)
Ontario	0.174***	0.137***	0.168***	0.168***	0.169***
	(0.031)	(0.027)	(0.031)	(0.034)	(0.030)
Manitoba	0.228***	0.183***	0.223***	0.231***	0.209***
	(0.039)	(0.034)	(0.039)	(0.046)	(0.024)
Saskatchewan	0.194***	0.144***	0.197***	0.251***	0.233***
	(0.050)	(0.044)	(0.053)	(0.043)	(0.012)
Alberta	0.226***	0.188***	0.223***	0.220***	0.217***
	(0.034)	(0.032)	(0.035)	(0.039)	(0.030)
British-Colombia	0.185***	0.160***	0.181***	0.184***	0.186***
	(0.033)	(0.026)	(0.034)	(0.036)	(0.019)
Age	0.00350	0.00380**	0.00375	0.00381	-0.00128
	(0.0023)	(0.0015)	(0.0024)	(0.0028)	(0.0012)
Age2	-0.0000149	-0.0000204	-0.0000191	-0.0000193	0.0000242**
	(0.000027)	(0.000016)	(0.000028)	(0.000033)	(0.000010)
Sex	0.0207	0.0270**	0.0230*	0.0258*	0.0214
	(0.014)	(0.011)	(0.014)	(0.015)	(0.014)
Urban	-0.0175	-0.0217*	-0.0207	-0.0220	-0.00739
	(0.018)	(0.012)	(0.019)	(0.023)	(0.0100)
Mother: Degree, diploma or certificate from college or university (Omitted)					
Some college or university	-0.00973	-0.0310	-0.0118	-0.0172	-0.0798***
	(0.020)	(0.021)	(0.020)	(0.022)	(0.017)
High school diploma	-0.0280**	-0.0294***	-0.0288**	-0.0287**	-0.0586***
	(0.012)	(0.0091)	(0.013)	(0.014)	(0.0076)
Less than a high school diploma	-0.0605***	-0.0679***	-0.0656***	-0.0585***	-0.0980***
	(0.015)	(0.011)	(0.015)	(0.014)	(0.0081)
Visible minority	-0.0455***	-0.0627***	-0.0486***	-0.0479***	0.0468
	(0.014)	(0.016)	(0.014)	(0.014)	(0.038)
Marital status	0.0176	0.0238*	0.0193	0.00509	0.0476***
	(0.017)	(0.012)	(0.017)	(0.013)	(0.011)
Degree, diploma or certificate from college or university(Omitted)					
Some college or university	-0.0403***	-0.0472***	-0.0402***	-0.0413**	-0.00791
	(0.015)	(0.012)	(0.015)	(0.017)	(0.015)
High school diploma	-0.0953***	-0.0895***	-0.0960***	-0.108***	-0.125***
	(0.019)	(0.018)	(0.020)	(0.018)	(0.018)
Less than a high school diploma	-0.0860***	-0.0949***	-0.0812***	-0.0831***	-0.134***
	(0.028)	(0.023)	(0.028)	(0.031)	(0.025)
Ethnic Fractionalization	-0.342***	-0.150	-0.321***	-0.338***	0.00649
	(0.11)	(0.11)	(0.11)	(0.12)	(0.081)
No religious affiliation (Omitted)					
Christian religion	-0.0440	-0.0527**	-0.0465*	-0.0507*	0.00338
	(0.027)	(0.021)	(0.028)	(0.030)	(0.018)
Non-Christian religion	-0.0188	-0.0108	-0.0191	-0.0277	0.0420***
	(0.022)	(0.015)	(0.023)	(0.024)	(0.011)
Language	-0.0376**	-0.0467***	-0.0384**	-0.0432***	0.0289
	(0.016)	(0.017)	(0.016)	(0.017)	(0.044)
Number of observations	8670	11860	8380	7480	10460
Number of clusters	38	37	35	34	38
Pseudo R2	0.0309	0.0345	0.0306	0.0306	0.0463

Notes: Robust standard errors adjusted for clustering by country of origin.
*** p<0.01, ** p<0.05, * p<0.1

Table 1.6: General Social Survey Estimates

Dependent variable : Trust	
	(1)
Country of origin level of trust	0.142**
	(0.058)
Quebec (Omitted)	0.125***
Atlantic	(0.019)
	0.108***
Ontario	(0.026)
	0.118*
Manitoba	(0.065)
	0.126***
Saskatchewan	(0.025)
	0.107***
Alberta	(0.024)
	0.0750***
British-Colombia	(0.022)
	-0.000447
Age	(0.0020)
	0.0000277
Age2	(0.000018)
	-0.000170
Sex	(0.018)
	-0.0317*
Urban	(0.019)
Mother: Degree, diploma or certificate from college or university (Omitted)	
Some college or university	-0.0149
	(0.056)
High school diploma	-0.0591**
	(0.025)
Less than a high school diploma	-0.0829***
	(0.022)
Visible minority	0.0184
	(0.041)
Marital status	0.0678***
	(0.019)
Degree, diploma or certificate from college or university(Omitted)	
Some college or university	-0.0503**
	(0.022)
High school diploma	-0.109***
	(0.033)
Less than a high school diploma	-0.0988***
	(0.034)
No religious affiliation (Omitted)	
Hierarchical religions	-0.0350
	(0.027)
Non-hierarchical religions	0.0357
	(0.025)
Number of observations	2534
Number of clusters	12
Pseudo R2	0.0346

Notes: Robust standard errors adjusted for clustering by country of origin.
*** p<0.01, ** p<0.05, * p<0.1

Chapter 2

Decomposing Health Achievement and Socioeconomic Health Inequalities in Presence of Multiple Categorical Information[23]

[23] This chapter draws on the work of a joint research project with Prof. Paul Makdissi and Dr. Myra Yazbeck.

2.1 Introduction

Health inequality measurement is essential for the implementation and the monitoring of health policies. Most of the current health inequality literature considers that the concentration index is an accepted measure of socioeconomic health inequality (see Wagstaff *et al.*, 1991). However, the use of the concentration index presents important measurement problems. First, it does not account for the average level of health status in the population considered (Wagstaff, 2002). Thus, a policy that improves the average level of health status, while keeping the relative distribution of health constant, will be deemed neutral when using the concentration index. To overcome this problem, Wagstaff (2002) recommends the use of an achievement index that captures simultaneously the average level of health status and the socioeconomic inequality of its distribution. As different health policy analysts may have different socioeconomic health inequality aversion, he proposes a parametric class of socioeconomic health inequality and health achievement indices that allows the analyst to choose the level of socioeconomic health inequality aversion.

Another measurement problem is the arbitrariness of the concentration index (for details see Erreygers, 2006; Zheng, 2008). It results from a common misuse of non-ratio-scaled variables, when computing inequality indices that are developed for ratio-scaled variables. Indeed, a large body of the health inequality measurement literature is based on the accumulated knowledge in income inequality measurement where the 0 has a well-defined meaning. In population surveys, most of the information on health status is given in the form of categorical variables where the meaning of 0 is not well defined. As a result the well-known income inequality indices cannot always be readily applied to measure inequalities in the health status. Zheng (2008) shows that changing the numerical scales associated with the categorical variables, while preserving the rank of the different categories, may change the ranking of the socioeconomic health inequality between two health distributions. As a result, the ranking produced by a socioeconomic health inequality index is arbitrary. Makdissi and Yazbeck (2014) suggest a solution that consists of using a counting approach that focuses on the breadth of health problems. This provides a well-

defined meaning to the value of 0, for any given health status. Thus, Wagstaff's class of health achievement and socioeconomic health inequality indices will produce consistent values and rankings.

In this paper, we use Makdissi and Yazbeck's (2014) counting approach to decompose the health achievement and the socioeconomic health inequality indices, by categories of health problems and by regions. In its general perspective, our work relates to Clarke *et al.* (2003) yet, it differs from it in three respects. First, Clarke *et al*. (2003) use a health related quality of life index (the SF-36) to assess the health status of each individual. We use Makdissi and Yazbeck's (2014) counting approach to assess individual health statuses. As in Clarke *et al*. (2003), we use standard decomposition techniques borrowed from the income inequality literature, and adapt them to the context of socioeconomic health inequality measurement. The resulting decomposition, by categories of health problems, flows naturally from the count framework adopted in this paper. Second, we adapt the decomposition techniques to the health achievement indices while Clarke *et al*. (2003) only focus on socioeconomic health inequality. The last difference resides in the empirical application's focus. While Clarke *et al*. (2003) use Australian data, we use United States data.

We believe that decomposing the CI is important from a policy perspective, especially when the policy's goal is to find mechanisms that can contribute to the reduction in health inequality. In this context, this decomposition will not only help to target the population group in need, but also identify the health aspects and the socioeconomic characteristics contributing to the health inequality (Lauridsen *et al*., 2007).

The remaining of this paper is organized as follows. The next section presents a brief literature review. Section 3 presents the theoretical framework. Section 4 describes our empirical application using the National Health Interview Survey 2010. The last section summarizes our results.

2.2 Literature Review

This paper is related to two lines of research. The first line of research focuses on health inequality measures, more precisely the health concentration index, while the second line investigates the decomposability of the health concentration index.

2.2.1 Measures of Health Inequality

Measures of health inequality provide information that allows decision makers to conduct policy that guarantees an efficient and equitable allocation of health care resources. One of the earliest economic contributions in health inequality literature (Le Grand, 1978) studies the relationship between public health care expenditures and socioeconomic groups. It shows that the high socioeconomic groups benefit more from the health services than the low socioeconomic groups. This seminal work led to an abundant research on the measurement of health inequality (among others, Le Grand and Rabin, 1986; Le Grand, 1989; Wagstaff *et al*., 1989; Wagstaff *et al*., 1991; van Doorslaer *et al*., 1997; Wagstaff, 2000; Wagstaff, 2002; Clarke *et al*., 2002; Clarke *et al.*, 2003). To measure health inequality in mortality, Le Grand (1989) and Le Grand and Rabin (1986) use the Lorenz curve and the Gini coefficient. Yet, measuring health related inequalities with the Gini coefficient ignores the socioeconomic aspect of health inequality. This is why Wagstaff *et al.* (1989) suggest that the use of the concentration index (CI hereafter), as a measure of socioeconomic health inequality, is more appropriate. The CI is also superior to the range measure (another index of socioeconomic health inequality) since it captures the socioeconomic aspect of health inequalities without stratifying the population by social class. Further, it varies according to the changes in the population's distribution across socioeconomic groups (Wagstaff *et al*., 1991).

The health CI and the health concentration curve are used to compare a wide variety of health outcome such as: adult health inequality (van Doorslaer *et al*., 1997), socioeconomic inequality in child mortality (Wagstaff, 2000), child immunization (Gwatkin *et al*., 2003), child malnutrition (Wagstaff *et al*., 2003), health care utilization (van Doorslaer *et al*., 2006), and health subsidies (O'Donnell *et al*., 2007).

However, the use of concentration index as a measure of socioeconomic health inequality, presents five important measurement problems.

First, the CI is insensitive to changes in the mean level of health (Wagstaff, 2002). Thus, a policy that improves the average level of health, while keeping the relative distribution of health constant, will be deemed neutral when using the concentration index. To address this issue, Wagstaff (2002) recommends the use of an achievement index, as it captures both the average level of health status and the socioeconomic inequality of its distribution. Second, the CI only permits for one specific type of value judgement, i.e., a particular weighting scheme (Wagstaff, 2002). As different health policy analysts may have different socioeconomic health inequality aversion, Wagstaff (2002) proposes a parametric class of socioeconomic health inequality aversion (the extended concentration index) based on the extended Gini index of Yitzhaki (1983). This extended concentration index permits a much wider ethical judgements about health inequality aversion.

Third, the CI does not satisfy the mirror property. This property necessitates that the CI measured using a variable that focuses on "good health" be the exact opposite of the CI measured using a variable that focuses on "ill health" (Clarke *et al*., 2002; Erreygers, 2009). In other words, if the mirror property is not satisfied, different rankings between countries can be obtained depending on whether the CI is based on health or morbidity. Clarke *et al.* (2002) find that the relative health inequality's ranking (i.e. the standard CI) between Sweden and Australia depends on whether the CI is based on health or morbidity. Erreygers (2009) shows that the CI of health is equal to the negative of the ratio of average ill health to average health, multiplied by the CI of shortfalls in health. He suggests a corrected version of the CI that addresses the mirror problem present in the standard concentration index. With the same objective, Erreygers *et al.* (2012) propose the generalized extended concentration index that considers the distances between health statuses and the average health status. However, the resulting index is not a relative inequality index. Although Lambert and Zheng (2011) show that no index of relative inequality can really avoid the mirror problem, we believe that this does not have serious repercussions. Our position in this paper is such that the variable

of interest is inequality in health attainments. Therefore, inequality in shortfalls must be accounted for in proportion of their contribution to total attainments' inequality.

The CI's blindness to health status (Makdissi and Yazbeck, 2012) is a fourth measurement issue that arises when CI is used to measure health inequalities. This is explained by the positive reaction of any Wagstaff's class of health achievement indices (or extended CI), when a health transfer is made from an individual at a lower rank in the health distribution to a person at a higher rank, provided that the former has a slightly higher income. The use of this type of indices, without accounting for blindness to health status, can be misleading if utilized in the evaluation of health policy performance. Makdissi and Yazbeck (2012) suggest a parametric class of indices that accounts simultaneously for pure health inequality and socioeconomic health inequality aversion.

The last measurement problem is the *arbitrariness of the concentration index* (for details see Erreygers, 2006; Zheng, 2008). It results from the common misuse of non-ratio-scaled variable while computing inequality indices that are developed for ratio-scaled variables. Indeed, a large body of health inequality measurement literature is based on the accumulated knowledge in income inequality measurement, where the 0 has a well-defined meaning. In population surveys, most of the information on health status is given in the form of categorical variables where the meaning of 0 is not well defined. As a result, the well-known income inequality indices cannot always be readily applied to measure inequalities in the health status. Zheng (2008) shows that changing the numerical scales associated with the categorical variables, while preserving the rank of the different categories, may change the ranking of socioeconomic health inequality between two health distributions. Makdissi and Yazbeck (2014) suggest a solution that consists of using a counting approach that focuses on the breadth of health problems. This provides to the value of 0, for a given health status, a well-defined meaning. Thus, the Wagstaff's class of health achievement and socioeconomic health inequality indices will produce consistent values and rankings.

2.2.2 Health Inequality Decomposition

There are three approaches to the decomposability of the health concentration index. The first follows the standard decomposition method of linear inequality measures. It is similar to the ones used in the income inequality literature, but adapted to the health concentration index. To measure the income-related health inequality, Clarke *et al*. (2003) use data from the 1995 Short Form (SF-36) survey of the general Australian population and decompose the concentration index by group and by source of health problems. They decompose the overall inequality of the physical functioning of the SF-36 into inequality in each of the ten items on which it is based.[24]

A second approach is the multivariate regression approach. It provides a decomposition by socioeconomic determinants of health inequality (see van Doorslaer and Jones, 2003; Wagstaff *et al*., 2003; van Doorslaer and Koolman, 2004). Wagstaff *et al*. (2003) use the multivariate regression approach to investigate the causes (determinants) of inequalities in child malnutrition in Vietnam in 1993 and 1998. They find that child malnutrition inequality is mainly explained by inequalities in household consumption and by inequalities in unobserved determinants at the commune level.

The last approach is a combination of the two earlier approaches (Lauridsen *et al.*, 2007; Gundgaard and Lauridsen, 2006; Lauridsen *et al*., 2006). Based on the 15D instrument data of the Finnish Health Care Survey of 1995/1996, Lauridsen *et al*. (2007) use this methodology to decompose the health concentration index into the 15 dimensions of the health instrument in addition to decomposing each dimension into different socioeconomic characteristics.

Building on Makdissi and Yazbeck's (2014), the present study provides a decomposition framework for the health achievement and socioeconomic health inequality by categories of health problems and by regions. In its general perspective, our work relates to Clarke *et al*. (2003) yet, it differs from it on three respects. First, Clarke *et al*. (2003) use a health related quality of life index (namely SF-36) to assess the health status of each observation. We use Makdissi and Yazbeck's (2014) counting

[24] They also applied the decomposition by subgroup by dividing their population into employed group and unemployed group.

approach to assess individual health statuses. As in Clarke *et al.* (2003), we use standard decomposition techniques from the income inequality literature and adapt them to the context of socioeconomic health inequality measurement. However, the decomposition by categories of health problems is much more natural in our count framework. Second, we adapt the decomposition techniques to the health achievement indices whereas Clarke *et al*. (2003) only focus on socioeconomic health inequality. The last difference resides in the empirical application's focus. While Clarke *et al*. (2003) use Australian data, we use United States data.

2.3 Theoretical Framework

2.3.1 A Parametric Class of Indices

In this section, we present Makdissi and Yazbeck's (2014) adaptation of Wagstaff's (2002) class of health achievement and socioeconomic health inequality indices. Let *F(y)* be the cumulative distribution of income *y*, and *p = F(y)* be the socioeconomic status of an individual whose income is *y*. The health information, for a given individual with socioeconomic status *p*, is categorical and provides information on *K* health attributes. Also, let $H(p) = (h_1(p), h_2(p), \dots, h_K(p))$ represent this information for an individual at socioeconomic rank *p*. For each health attribute *k*, assume that there exists a threshold category, τ_k, below which the person is considered to have a health problem in that attribute. Given the following transformation:

$$\Upsilon(H(p)) = (\iota[h_1(p) < \tau_1], \iota[h_2(p) < \tau_2], \dots, \iota[h_K(p) < \tau_K]), \qquad (2.1)$$

where $\iota[x < x_0]$ is an indicator function that takes a value of 1 if $x < x_0$ and 0 otherwise. It is trivial that $\Upsilon(H(p)) = \Upsilon(g(H(p)))$ for any increasing monotonic transformation $g(.)$ since $g_k\big(h_k(p)\big) < g_k(\tau_k)$ if and only if $h_k(p) < \tau_k$. Thus changing the numerical scale associated with the categorical ranking will not change the value of $\Upsilon(H(p))$. Let $\Theta = (\theta_1, \theta_2, \dots, \theta_K)$ be a vector of weights for health attributes where the

taxicab norm[25] $\|\Theta\|_1$ is equal to *K*.[26] The width of health problems is then given by $s(H(p))$ where $s(H(p)) = \Upsilon(H(p))\Theta'$ is the weighted sum of health attributes in which an individual has a health problem. To aggregate this information, Makdissi and Yazbeck (2014) suggest the following procedure:

$$\phi(H(p)) = \frac{K - s(H(p))}{K}, \quad (2.2)$$

The resulting measure in (2.2), is a quantification of an individual's health achievement since it represents the weighted proportion of health attributes without problems. It is clearly a ratio-scaled variable, as the 0 is reached when an individual experiences problems in each of the *K* health attributes. Also, this measure is invariant to any monotonic transformation of the values associated to health categories; it overcomes the arbitrariness problem mentioned in the introduction. However, this consistency is not without a cost at the level of the depth of the health problem in each health attribute. Using equation (2.2), Makdissi and Yazbeck (2014) adapt Wagstaff's (2002) parametric class of indices. Based on their counting approach, the indices produce results that are invariant to changes in the numerical values associated to the different categories of a health attribute, as long as the rank between the categories is maintained. The resulting population health index for this class is given by:

$$A_\eta(H) = \int_0^1 \eta(1-p)^{\eta-1}\,\phi(H(p))dp, \qquad \eta > 1, \quad (2.3)$$

where the parameter η can be interpreted as a parameter of socioeconomic health inequality aversion (see Yitzhaki, 1983). The socioeconomic health inequality is measured by the generalized concentration index, it is equal to the relative loss due to socioeconomic health inequality as a proportion of the average health status:

$$I_\eta(H) = 1 - \frac{A_\eta(H)}{\mu_\phi}, \qquad \eta > 1, \quad (2.4)$$

where $\mu_\phi = \int_0^1 \phi(H(p))dp$ is the average health status. When $\eta = 2$, we obtain the standard concentration index that is widely used in the health economics literature. The general class of concentration indices given

[25] Note that the taxicab norm of a vector $x = (x_1, x_2, \ldots, x_n)$ is defined by $\|x\|_1 \coloneqq \sum_{i=1}^{n} |x_i|$

[26] One specific example of a weight vector Θ is a vector of ones, *e*. We will use the weight vector *e* in the empirical part of this paper since it is consistent with the weighting of different health attribute used in many HRQL indices (see Kopec and Willison, 2003).

by equation (2.4) allows the decision maker to choose the level of socioeconomic health inequality aversion that can be lower (if $\eta \in (1,2)$) or higher (if $\eta > 2$) than the level associated with the standard concentration index.

2.3.2 Decomposition by Categories of Health Problems

In this section, we develop a decomposition for the Makdissi and Yazbeck's (2014) counting approach. This decomposition provides insights on the contribution of each and every attribute in socio-economic health inequalities. Using equation (2.2), we can rewrite the index laid in equation (2.3) as follows:

$$A_\eta(H) = \int_0^1 \eta(1-p)^{\eta-1} \frac{K - \sum_k^K \theta_k \iota[h_k(p) < \tau_k]}{K} dp$$

$$A_\eta(H) = 1 - \frac{1}{K}\sum_{k=1}^K \theta_k A_\eta(h_k), \quad (2.5)$$

Where $A_\eta(h_k) = \int_0^1 \eta(1-p)^{\eta-1} \iota[h_k(p) < \tau_k]dp$ represents a "failure" in health attribute *k*.[27] It takes a value of 0 if nobody suffers from a problem in this health attribute, and a value of 1 if everyone has a problem in this health attribute. Equation (2.5) gives a convenient decomposition of health achievement as a weighted average of failures in the K health attributes.

Turning our attention to the decomposition of socioeconomic health inequality, we define the concentration index of a health problem in attribute k as follows:

$$I_\eta(h_k) = 1 - \frac{A_\eta(h_k)}{\mu_k}, \quad (2.6)$$

where $\mu_k = \int_0^1 \iota[h_k(p) < \tau_k]dp$ is the proportion of the population having a health problem in the attribute *k*. Using equations (2.4) and (2.5), we obtain the following:

$$I_\eta(H) = 1 - \frac{1}{\mu_\phi} \frac{K - \sum_{k=1}^K \theta_k A_\eta(h_k)}{K}, \quad (2.7)$$

Using equation (2.6), equation (2.7) can be rewritten as:

[27] Here, we use the term "failure" as an antonym of "achievement. It represents the socially weighted average of health problems in that attribute.

$$I_\eta(H) = 1 - \frac{1}{\mu_\phi}\frac{K - \sum_{k=1}^{K}\theta_k\mu_k(1 - I_\eta(h_k))}{K}, \quad (2.8)$$

where $I_\eta(h_k)$ is the generalized concentration index of problems in health attribute *k*. By averaging equation (2.2), we obtain the following:

$$\mu_\phi = \frac{K - \sum_{k=1}^{K}\theta_k\mu_k}{K}, \quad (2.9)$$

Using equation (2.9), equation (2.8) can be rewritten as:

$$I_\eta(H) = -\frac{1}{K}\sum_{k=1}^{K}\theta_k\frac{\mu_k}{\mu_\phi}I_\eta(h_k), \quad (2.10)$$

The examination of equation (2.10) reveals 3 possible pathways through which a problem in attribute *k* can affect total health inequality. First, a higher socioeconomic inequality in attribute *k* (lower value of $I_\eta(h_k)$) may increase the contribution of this health problem, in the attribute *k*, to total socioeconomic health inequality. The impact of a problem in an attribute *k* flowing through the two other pathways depends on the sign of $I_\eta(h_k)$. When $I_\eta(h_k) < 0$ (indicating a concentration of these health problems in the bottom of the income distribution), the larger is the share of the total population that experiences health problems in attribute *k* (higher μ_k) the higher is its contribution to total socioeconomic health inequality. If the importance of attribute *k* in total health status (higher θ_k) is increased, then its contribution to total health inequality increases (if $I_\eta(h_k) < 0$). The opposite result holds when $I_\eta(h_k) > 0$.

2.3.3 Decomposition by Population Groups

For *J* population groups, the health achievement index can be written as:

$$A_\eta(H) = \sum_{j=1}^{J}\sigma_j\, A_\eta(H_j) + A_\eta^R(H), \quad (2.11)$$

where $A_\eta(H_j)$ is the achievement index of group *j*, σ_j is the population share of group *j* and $A_\eta^R(H)$ is a residual term that is due to the difference between the rank of observations within their group and their rank in the overall population. For the decomposition of socioeconomic health inequality by population group, we follow closely Clarke *et al*. (2003) and use the standard decomposition of an inequality index from the income inequality literature. Thus the generalized concentration index can be rewritten as:

$$I_\eta(H) = I_\eta^W(H) + I_\eta^B(H) + I_\eta^R(H), \quad (2.12)$$

where $I_\eta^W(H)$ represents the within group socioeconomic health inequality, $I_\eta^B(H)$, the between group socioeconomic health inequality. $I_\eta^R(H)$ is a residual term that is due to the intersection between the health distribution supports of the different population groups. The within group socioeconomic health inequality is obtained by:

$$I_\eta^W(H) = \sum_{j=1}^{J} \sigma_j^2 \frac{\mu_{\phi_j}}{\mu_\phi} I_\eta(H_j), \quad (2.13)$$

Where $I_\eta(H_j)$ represents the socioeconomic health inequality of population group j, and μ_{ϕ_j} represents its corresponding average health status.

2.4 Decomposing Health Achievement and Socioeconomic Health Inequality in the United States

The objective of this section is to provide a general picture of the structure of the health achievements and of the socioeconomic health inequalities in the United States.

2.4.1 The Data

We use the public use files of the 2010 National Health Interview Survey (NHIS). It is a cross-sectional household interview survey that is representative of households and non-institutional group quarters. The NHIS contains data on a broad range of health outcomes that are collected through personal household interviews. We use the representative sub-sample, for which the Quality of Life questionnaire has been filled. The representative sub-sample covers 6775 individuals. We focus on the adult population only.[28] The final sample size is 6005 observations. For this empirical application, we utilise information on household income to infer the individual's socioeconomic rank. As for the information on the individual's health status, it is based on the following eleven categorical variables: vision, hearing, ambulation, communication,

[28] Population aged 18 years and above.

cognition, dexterity, learning capacity, anxiety, depression, pain and exhaustion. We fix the vector of threshold $\tau = (\tau_1, \tau_2, \dots, \tau_{11})$ as detailed in Table 2.1. All along this empirical application, we will consider four different values of the socioeconomic health inequality aversion parameter η (i.e., η = 1.5, 2, 2.5 and 3).[29] As for the weight vector, we assume that an equal weight is given to each attribute (i.e. $\Theta = e$, where e is a vector of ones). This practice is consistent with what is usually implemented in the epidemiology literature (see Kopec and Willison, 2003).

2.4.2 Decomposition by Categories of Health Problems

We first consider the decomposition of health achievement and socioeconomic health inequality by categories of health problems. The purpose of this kind of decomposition (by source) is to assess the relative importance of each category of health problems in the total health achievement, as well as in total socioeconomic health inequality.

Table 2.2, gives the failure index of each health attribute for the four values of the socioeconomic health inequality aversion parameter, as well as for η = 1. When η = 1, the failure index $A_\eta(h_k)$ reflects the share of the total population experiencing a problem in health attribute k. The attributes for which this index is highest are Exhaustion, Anxiety and Depression. These results seem to indicate that the proportion of the total population experiencing problems in these health attributes is high. This result may be interpreted as a supporting evidence in favour of the social importance of mental health problems. Yet, one has to be cautious when interpreting these results, as the threshold was met, as soon as the questions were not answered with "never". As will be shown in section 4.5 below, a more conservative threshold may produce different results.[30] Table 2.3, displays the relative contributions of problems, in each health attribute, to the deviation from perfect health, $\frac{\theta_k}{K} A_\eta(h_k) / \left[1 - A_\eta(H)\right]$. The picture stays the same for all levels of

[29] The standard health concentration index (and its associated health achievement index) is obtained when η = 2.
[30] Our results may be sensitive to the number of attribute chosen. More attributes may produce different results. We focus only on the Quality of Life questionnaire attributes.

socioeconomic health inequality aversion: Exhaustion, Anxiety and Depression remain the three leading contributors to the deviation from perfect health.

The decomposition of socioeconomic health inequality is presented in Table 2.4 and in Table 2.5. While Table 2.4 presents the concentration indices of health problem for each health attribute, Table 2.5 displays their relative contribution to total socioeconomic health inequality. A brief examination of these tables shows that the results are consistent for all four level of socioeconomic health inequality aversion parameter, η. When we focus on the relative contribution of problems in each health attribute to the total socioeconomic health inequality, a striking difference can be noticed for two attributes: Anxiety and Exhaustion. Their individual contributions to total socioeconomic health inequality are less than 2%. This result indicates that these health problems are more equally distributed over all socioeconomic statuses, which is also confirmed by the low absolute value of their concentration indices in Table 2.4.[31] The three main contributors to total socioeconomic health inequality are thus Ambulation, Depression and Pain. This finding seems to be consistent with the literature on socioeconomic health inequality (see Koster *et al.* (2004) for Ambulation, Lorant *et al*. (2003) and Lorant *et al*. (2007) for Depression and Brekke *et al.* (2002) for Pain).[32] The ranking of the relative contribution of Depression is consistent with its corresponding ranking in the total contribution to total deviation from perfect health. However, this is not the case for Ambulation and Pain, given that their contribution to total deviation from perfect health is marginal. While these two problematic attributes do not have an impact on a large portion of total population, their impacts are mainly on individuals with low socioeconomic statuses. The high absolute value of their concentration indices confirms this hypothesis.

[31] It is important to note that a more conservative threshold for these attributes may produce different results.
[32] Note that, Koster *et al*. (2004) used Dutch data, Lorant *et al.* (2003) carried a Meta-Analysis using data from different countries and Lorant *et al.* (2007) used Belgian Panel data. As for Brekke *et al.* (2002), they used data from Norway.

2.4.3 Regional Decomposition

In this part of the empirical application, we consider the regional decomposition of health achievement and socioeconomic health inequality. For this reason, we partition the United States into four regions: the Northeast, the South, the Midwest and the West. The purpose of performing a regional decomposition is to assess the importance of inter-regional socioeconomic health inequality in total socioeconomic health inequality.

First, we focus on health achievement. Table 2.6 presents the average health status (η = 1) for the United States and for each of the four regions.[33] In addition, it provides, for the four different parameter values of η, the estimates of the health achievement index and its decomposition given by equation (2.11). If we consider the regional averages (i.e., η = 1), the observed ranking between the regions (from the highest to the lowest average status) is West, Northeast, South and Midwest.

When we allow for socioeconomic inequality aversion in the health achievement index (i.e., η > 1), the ranking of the West when compared to the other regions remains the same for the four values of the socioeconomic health inequality aversion parameter, η. Similarly, the ranking between the Northeast and the South stays the same for the four values of socioeconomic health inequality aversion parameter η. However, the relative position of the Midwest, compared to the South and the Northeast, improves when increasing socioeconomic health inequality aversion (η). When η = 2 and 2.5, the Midwest has a higher health achievement index than the South. When η = 3, it outperforms the Northeast region. This suggests that socioeconomic health inequality in the Midwest is lower than in the Northeast and the South. Finally, we notice that the residual term, has a very low value. This indicates that there are not a lot of differences between the socioeconomic rank of individuals within their region and their national socioeconomic rank.

Let us now focus on socioeconomic health inequality. Table 2.7 displays the estimates of the socioeconomic health inequality indices, and their decomposition given by equations (2.12) and (2.13), for different values of the socioeconomic health inequality aversion parameter η. Table 2.8 presents the relative

[33] Note that from equation (2.3), we obtain $A_1(H) = \mu_\phi$.

contribution of the three components of inequality in equation (2.12). From Table 2.7, it appears that socioeconomic health inequality is substantially higher in the South and the Northeast than in the Midwest and the West. This explains why, despite a lower average health status, the Midwest's achievement index exceeds the South's and even the Northeast's achievement index, when the socioeconomic health inequality aversion parameter is increased. Another interesting observation is that the ranking remains unchanged for the four values of η (see Table 2.7). The region with the lowest level of socioeconomic health inequality is the Midwest, followed by the West, the Northeast and then the South.

From Table 2.8, we notice that within regions socioeconomic health inequality explains around 28% of total socioeconomic health inequality. The contribution of the socioeconomic health inequality between the regions depends on the value of the socioeconomic health inequality aversion parameter. For η = 1.5, the socioeconomic health inequality between regions has a negative contribution to the total socioeconomic health inequality. However, this result changes once one increases the socioeconomic health inequality aversion parameter. When η = 3, the socioeconomic health inequality between the United States regions explains 75% of the total socioeconomic health inequality at the national level with a residual of -3.2%. The fact that the contribution to total inequality is contingent to the inequality aversion parameter is consistent with recent findings in the literature by Mornet *et al.* (2012) in the context of a population group decomposition of income inequality in France.

2.4.4 Sensitivity Analysis

For the last part of our empirical analysis, we test the sensitivity of our results by changing the threshold for the following health attributes: Anxiety, Depression and Exhaustion.

Case 1:

Threshold is met if the problems of anxiety and depression occur more than "A few times a year".

Threshold is met if the problem of exhaustion occurs more than "Some days".

When η = 1, the problems of Ambulation, Anxiety and Pain affect a larger share of total population respectively 18.73%, 29.84% and 23.93% (see Table 2.2a). When the socioeconomic health inequality aversion parameter η takes the values 1.5, 2 and 2.5, the failure indices $A_\eta(h_k)$ of Ambulation, Anxiety and Pain remain the highest. However, for η = 3, the failure indices of Anxiety, Depression and Exhaustion become the highest. The same analysis can be conducted to study the relative contribution of problems in health attributes to deviation from perfect health (see Table 2.3a). Table 2.5a, displaying the relative contribution of problems in each attribute to total socioeconomic health inequality, shows that Ambulation, Depression and Pain are the major sources of total socioeconomic health inequality. Table 2.6a presents the health achievement by region. When η takes the values 1 and 1.5, we have the following descending order health achievement: West, Northeast, Midwest and South. The ranking becomes West, Midwest, Northeast and South, when η takes the values 2, 2.5 and 3. Table 2.7a reveals that the socioeconomic health inequality is higher in the South and Northeast, than the West and Midwest.

Case 2:

Threshold is met if the problems of anxiety and depression occur more than "Monthly".

Threshold is met if the problem of exhaustion occurs more than "Some days".

Similar to the **Case 1**, Table 2.2b shows that the failure indices $A_\eta(h_k)$ of Ambulation, Anxiety and Pain are the highest when η takes the values 1, 1.5, 2 and 2.5. However, the failure indices of Anxiety, Pain and Exhaustion are the highest when η = 3. A similar analysis can be performed for the examination of the relative contribution of problems in health attributes to deviation from perfect health (see Table 2.3b). Table 2.5b, presenting relative contribution of problems in each attribute to total socioeconomic health inequality, shows that Ambulation, Depression and Pain are the major sources of total socioeconomic health inequality. Table 2.6b presents the health achievement by region. When η takes the values 1, we have the following descending order by health achievement: West, Northeast, Midwest and South. The ranking becomes West, Midwest, Northeast and South when η takes the values 1.5, 2, 2.5 and 3. Table 2.7b reveals that the socioeconomic health inequality is higher in the South and Northeast than the West and Midwest.

As expected, the values of the failure index, the achievement index and the socioeconomic health inequality and their relative contributions are sensitive to the threshold set. The change in the thresholds of Anxiety, Depression and Exhaustion made the Ambulation, Anxiety and Pain the major problems that the population suffers from when η takes the values 1, 1.5, 2 and 2.5. However in our baseline case, the population is more affected by Anxiety, Depression and Exhaustion (see Table 2.2). In addition, in our baseline case, the South has the highest level of socioeconomic health inequality, followed by the Northeast, the West and the Midwest. This ranking is not sensitive to the value of η. However, in the sensitivity analysis (i.e., in **Case 1** and **Case 2**) the ranking seem to be sensitive to the value of health inequality aversion parameter. When η is equal to 1.5, South is the region with the highest level of socioeconomic health inequality, followed by the Northeast, the Midwest and the West. However, when η takes the values 2, 2.5 and 3, the ranking becomes the Northeast, followed by the South, the Midwest and the West.

2.5 Conclusion

In this paper, we propose a decomposition of the health achievement and the socioeconomic health inequality indices for multiple categorical variables. We adopt Makdissi and Yazbeck's (2014) counting approach to deal with the ordinal nature of the data. This approach offers a natural setting for the decomposition of the health achievement and the socioeconomic health inequality indices by categories of health problems. Our findings suggest that the attributes that contribute the most to the deviation from perfect health in the United States are: Anxiety, Depression and Exhaustion. Also, we find that the attributes that contribute the most to the total socioeconomic health inequality are Ambulation, Depression and Pain. In addition to the decomposition by health attribute, we perform a regional decomposition of the socioeconomic health inequality. The obtained results suggest that, if the aversion to socioeconomic health inequality is high enough, socioeconomic health inequalities between regions are the main contributors to the total socioeconomic health inequality in the United States.

However, the values of the failure index, the achievement index and the socioeconomic health inequality and their relative contributions are sensitive to the threshold set. The change in the thresholds of Anxiety, Depression and Exhaustion altered the ranking of health problems. More specifically, it made the Ambulation, Anxiety and Pain the major problems that the population suffers from when η takes the values 1, 1.5, 2 and 2.5 (whereas it was Exhaustion, Anxiety and Depression with the initial threshold levels). Moreover, the sensitivity analysis reveals that the rankings of the regions according to the achievement index and socioeconomic health inequality are also sensitive to the threshold set.

Appendix 2: Tables

Table 2.1: Attributes Threshold Definitions (NHIS)

Attribute	**Threshold met if positively answered the following questions. Do you have:**
Vision	difficult vision even with glasses?
Hearing	difficult hearing even with a hearing Aid?
Ambulation	difficulty walking or climbing steps?
Communication	difficulty in understanding or being understood in your native language?
Cognition	difficulty remembering or concentrating?
Dexterity	difficulty with self-care (washing all over, dressing)?
Learning Capacity	learning the rules of a new game? OR following instructions (use a new cell phone get to a new place)?
Pain	frequent pain?
Attribute	**Threshold met if answer is different from "never" to the following questions**
Anxiety	How often do you feel worried, nervous, anxious?
Depression	How often do you feel depressed?
Exhaustion	How often did you feel very tired exhausted (in past 3 months)?

Table 2.2: Failure in Health Attributes

	$\eta = 1$	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	0.143048	0.15367	0.161179	0.166602	0.170608
Hearing	0.114072	0.117843	0.119903	0.120837	0.121156
Ambulation	0.187344	0.205231	0.216777	0.224425	0.229591
Communication	0.052956	0.059956	0.06527	0.069349	0.072534
Cognition	0.160366	0.172615	0.180217	0.185013	0.18805
Dexterity	0.034638	0.040205	0.044436	0.047595	0.049937
Learning Capacity	0.135387	0.147854	0.156123	0.161398	0.164728
Anxiety	0.593505	0.595267	0.595889	0.596113	0.596161
Depression	0.418984	0.434949	0.446071	0.454143	0.46021
Pain	0.239301	0.254622	0.264067	0.270506	0.27511
Exhaustion	0.607494	0.609485	0.609941	0.610076	0.610041

Table 2.3: Relative Contribution of Problems in Health Attributes to Deviation from Perfect Health

	$\eta = 1$	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	5.32%	5.50%	5.64%	5.73%	5.81%
Hearing	4.25%	4.22%	4.19%	4.16%	4.12%
Ambulation	6.97%	7.35%	7.58%	7.72%	7.81%
Communication	1.97%	2.15%	2.28%	2.39%	2.47%
Cognition	5.97%	6.18%	6.30%	6.37%	6.40%
Dexterity	1.29%	1.44%	1.55%	1.64%	1.70%
Learning Capacity	5.04%	5.30%	5.46%	5.55%	5.61%
Anxiety	22.09%	21.32%	20.84%	20.51%	20.29%
Depression	15.59%	15.58%	15.60%	15.63%	15.66%
Pain	8.91%	9.12%	9.23%	9.31%	9.36%
Exhaustion	22.61%	21.83%	21.33%	20.99%	20.76%

Table 2.4: Concentration of Health Problem by Attribute

	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	-0.07426	-0.12675	-0.16466	-0.19267
Hearing	-0.03306	-0.05112	-0.05931	-0.06211
Ambulation	-0.09547	-0.15711	-0.19793	-0.2255
Communication	-0.13219	-0.23253	-0.30956	-0.3697
Cognition	-0.07638	-0.12378	-0.15369	-0.17263
Dexterity	-0.16073	-0.28288	-0.37406	-0.44169
Learning Capacity	-0.09208	-0.15316	-0.19212	-0.21672
Anxiety	-0.00297	-0.00402	-0.00439	-0.00448
Depression	-0.0381	-0.06465	-0.08392	-0.0984
Pain	-0.06402	-0.1035	-0.1304	-0.14964
Exhaustion	-0.00328	-0.00403	-0.00425	-0.00419

Table 2.5: Relative Contribution of Problems in each Attribute to Total Socioeconomic Health Inequality

	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	10.2%	10.5%	10.8%	11.0%
Hearing	3.6%	3.4%	3.1%	2.8%
Ambulation	17.1%	17.0%	16.9%	16.8%
Communication	6.7%	7.1%	7.5%	7.8%
Cognition	11.7%	11.5%	11.3%	11.0%
Dexterity	5.3%	5.7%	5.9%	6.1%
Learning Capacity	11.9%	12.0%	11.9%	11.7%
Anxiety	1.7%	1.4%	1.2%	1.1%
Depression	15.3%	15.7%	16.1%	16.4%
Pain	14.6%	14.3%	14.3%	14.3%
Exhaustion	1.9%	1.4%	1.2%	1.0%

Table 2.6: Health Achievement

	Northeast	South	Midwest	West	Total	Residual
$\eta = 1$	0.759513	0.754541	0.746483	0.763237	0.755719	
$\eta = 1.5$	0.748632	0.74162	0.740472	0.756851	0.760028	0.013717
$\eta = 2$	0.740375	0.733239	0.73708	0.752753	0.75403	0.013891
$\eta = 2.5$	0.734032	0.727526	0.735302	0.750099	0.746983	0.011012
$\eta = 3$	0.729109	0.723481	0.734477	0.74834	0.738623	0.005546

Table 2.7: Inequality Decomposition

	Northeast	South	Midwest	West	I_η^W	I_η^B	Total	Residual
$\eta = 1.5$	0.014326	0.017125	0.008052	0.008367	0.003572	-0.0057	0.012571	0.014701
$\eta = 2$	0.025198	0.028232	0.012595	0.013736	0.005893	0.002234	0.020784	0.012657
$\eta = 2.5$	0.033549	0.035804	0.014978	0.017214	0.007453	0.011559	0.026342	0.007329
$\eta = 3$	0.033549	0.035804	0.014978	0.017214	0.008534	0.022621	0.0302	-0.00096

Table 2.8: Relative Contribution to Total Inequality

	I_η^W	I_η^B	Residual
$\eta = 1.5$	28.4%	-45.4%	116.9%
$\eta = 2$	28.4%	10.7%	60.9%
$\eta = 2.5$	28.3%	43.9%	27.8%
$\eta = 3$	28.3%	74.9%	-3.2%

Threshold is met if the problems of anxiety and depression occur more than "A few times a year". Threshold met if the problem of exhaustion occurs more than "Some days".

Table 2.2a: Failure in Health Attributes

	$\eta = 1$	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	0.143048	0.15367	0.161179	0.166602	0.170608
Hearing	0.114072	0.117843	0.119903	0.120837	0.121156
Ambulation	0.187344	0.205231	0.216777	0.224425	0.229591
Communication	0.052956	0.059956	0.06527	0.069349	0.072534
Cognition	0.160366	0.172615	0.180217	0.185013	0.18805
Dexterity	0.034638	0.040205	0.044436	0.047595	0.049937
Learning Capacity	0.135387	0.147854	0.156123	0.161398	0.164728
Anxiety	0.298418	0.309038	0.316417	0.322133	0.596161
Depression	0.16786	0.187776	0.201939	0.21285	0.46021
Pain	0.239301	0.254622	0.264067	0.270506	0.27511
Exhaustion	0.112739	0.123326	0.130883	0.136402	0.610041

Table 2.3a: Relative Contribution of Problems in Health Attributes to Deviation from Perfect Health

	$\eta = 1$	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	8.7%	8.7%	8.7%	8.7%	5.8%
Hearing	6.9%	6.6%	6.5%	6.3%	4.1%
Ambulation	11.4%	11.6%	11.7%	11.7%	7.8%
Communication	3.2%	3.4%	3.5%	3.6%	2.5%
Cognition	9.7%	9.7%	9.7%	9.7%	6.4%
Dexterity	2.1%	2.3%	2.4%	2.5%	1.7%
Learning Capacity	8.2%	8.3%	8.4%	8.4%	5.6%
Anxiety	18.1%	17.4%	17.0%	16.8%	20.3%
Depression	10.2%	10.6%	10.9%	11.1%	15.7%
Pain	14.5%	14.4%	14.2%	14.1%	9.4%
Exhaustion	6.8%	7.0%	7.0%	7.1%	20.8%

Table 2.4a: Concentration of Health Problem by Attribute

	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	-0.07426	-0.12675	-0.16466	-0.19267
Hearing	-0.03306	-0.05112	-0.05931	-0.06211
Ambulation	-0.09547	-0.15711	-0.19793	-0.2255
Communication	-0.13219	-0.23253	-0.30956	-0.3697
Cognition	-0.07638	-0.12378	-0.15369	-0.17263
Dexterity	-0.16073	-0.28288	-0.37406	-0.44169
Learning Capacity	-0.09208	-0.15316	-0.19212	-0.21672
Anxiety	-0.03559	-0.06032	-0.07947	-0.09521
Depression	-0.11865	-0.20302	-0.26802	-0.31984
Pain	-0.06402	-0.1035	-0.1304	-0.14964
Exhaustion	-0.09391	-0.16093	-0.20989	-0.2463

Table 2.5a: Relative Contribution of Problems in each Attribute to Total Socioeconomic Health Inequality

	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	8.4%	8.6%	8.7%	8.8%
Hearing	3.0%	2.8%	2.5%	2.3%
Ambulation	14.2%	13.9%	13.7%	13.4%
Communication	5.6%	5.8%	6.0%	6.2%
Cognition	9.7%	9.4%	9.1%	8.8%
Dexterity	4.4%	4.6%	4.8%	4.9%
Learning Capacity	9.9%	9.8%	9.6%	9.3%
Anxiety	8.4%	8.5%	8.8%	9.0%
Depression	15.8%	16.1%	16.6%	17.1%
Pain	12.2%	11.7%	11.5%	11.4%
Exhaustion	8.4%	8.6%	8.7%	8.8%

Table 2.6a: Health Achievement

	Northeast	South	Midwest	West	Total	Residual
$\eta = 1$	0.852952	0.846323	0.847538	0.857048	0.850352	
$\eta = 1.5$	0.839293	0.832284	0.838724	0.848763	0.855237	0.016252
$\eta = 2$	0.829139	0.822801	0.833273	0.843285	0.848322	0.017022
$\eta = 2.5$	0.821318	0.816186	0.829805	0.83953	0.840125	0.014214
$\eta = 3$	0.815161	0.811435	0.82754	0.836838	0.830422	0.008417

Table 2.7a: Inequality Decomposition

	Northeast	South	Midwest	West	I_η^W	I_η^B	Total	Residual
$\eta = 1.5$	0.016015	0.016589	0.0104	0.009667	0.003739	-0.00574	0.01346	0.015465
$\eta = 2$	0.027919	0.027794	0.016831	0.016058	0.006255	0.002388	0.022566	0.013923
$\eta = 2.5$	0.037088	0.03561	0.020922	0.02044	0.008008	0.012027	0.028971	0.008935
$\eta = 3$	0.044307	0.041224	0.023595	0.023581	0.00927	0.023437	0.033621	0.000913

Table 2.8a: Relative Contribution to Total Inequality

	I_η^W	I_η^B	Residual
$\eta = 1.5$	27.8%	-42.7%	114.9%
$\eta = 2$	27.7%	10.6%	61.7%
$\eta = 2.5$	27.6%	69.7%	2.7%
$\eta = 3$	27.6%	69.7%	2.7%

Threshold is met if the problems of anxiety and depression occur more than "Monthly".
Threshold met if the problem of exhaustion occurs more than "Some days".

Table 2.2b: Failure in Health Attributes

	$\eta = 1$	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	0.143048	0.15367	0.161179	0.166602	0.170608
Hearing	0.114072	0.117843	0.119903	0.120837	0.121156
Ambulation	0.187344	0.205231	0.216777	0.224425	0.229591
Communication	0.052956	0.059956	0.06527	0.069349	0.072534
Cognition	0.160366	0.172615	0.180217	0.185013	0.18805
Dexterity	0.034638	0.040205	0.044436	0.047595	0.049937
Learning Capacity	0.135387	0.147854	0.156123	0.161398	0.164728
Anxiety	0.199667	0.211269	0.219726	0.226255	0.231503
Depression	0.097419	0.113187	0.124753	0.133805	0.141081
Pain	0.239301	0.254622	0.264067	0.270506	0.27511
Exhaustion	0.112739	0.123326	0.130883	0.136402	0.610041

Table 2.3b: Relative Contribution of Problems in Health Attributes to Deviation from Perfect Health

	$\eta = 1$	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	9.7%	9.6%	9.6%	9.6%	7.6%
Hearing	7.7%	7.4%	7.1%	6.9%	5.4%
Ambulation	12.7%	12.8%	12.9%	12.9%	10.2%
Communication	3.6%	3.7%	3.9%	4.0%	3.2%
Cognition	10.9%	10.8%	10.7%	10.6%	8.3%
Dexterity	2.3%	2.5%	2.6%	2.7%	2.2%
Learning Capacity	9.2%	9.2%	9.3%	9.3%	7.3%
Anxiety	13.5%	13.2%	13.1%	13.0%	10.3%
Depression	6.6%	7.1%	7.4%	7.7%	6.3%
Pain	16.2%	15.9%	15.7%	15.5%	12.2%
Exhaustion	7.6%	7.7%	7.8%	7.8%	27.1%

Table 2.4b: Concentration of Health Problem by Attribute

	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	-0.07426	-0.12675	-0.16466	-0.19267
Hearing	-0.03306	-0.05112	-0.05931	-0.06211
Ambulation	-0.09547	-0.15711	-0.19793	-0.2255
Communication	-0.13219	-0.23253	-0.30956	-0.3697
Cognition	-0.07638	-0.12378	-0.15369	-0.17263
Dexterity	-0.16073	-0.28288	-0.37406	-0.44169
Learning Capacity	-0.09208	-0.15316	-0.19212	-0.21672
Anxiety	-0.05811	-0.10046	-0.13316	-0.15944
Depression	-0.16186	-0.28059	-0.3735	-0.44819
Pain	-0.06402	-0.1035	-0.1304	-0.14964
Exhaustion	-0.09391	-0.16093	-0.20989	-0.2463

Table 2.5b: Relative Contribution of Problems in each Attribute to Total Socioeconomic Health Inequality

	$\eta = 1.5$	$\eta = 2$	$\eta = 2.5$	$\eta = 3$
Vision	8.6%	8.8%	8.9%	9.0%
Hearing	3.1%	2.8%	2.6%	2.3%
Ambulation	14.6%	14.3%	14.0%	13.7%
Communication	5.7%	6.0%	6.2%	6.4%
Cognition	10.0%	9.6%	9.3%	9.0%
Dexterity	4.5%	4.7%	4.9%	5.0%
Learning Capacity	10.1%	10.0%	9.8%	9.5%
Anxiety	9.4%	9.7%	10.0%	10.3%
Depression	12.8%	13.2%	13.7%	14.2%
Pain	12.5%	12.0%	11.8%	11.6%
Exhaustion	8.6%	8.8%	8.9%	9.0%

Table 2.6b: Health Achievement

	Northeast	South	Midwest	West	Total	Residual
$\eta = 1$	0.866354	0.860831	0.865463	0.872703	0.865733	
$\eta = 1.5$	0.852652	0.847203	0.856765	0.864835	0.870832	0.016193
$\eta = 2$	0.842551	0.837928	0.851337	0.859521	0.863766	0.016682
$\eta = 2.5$	0.834833	0.831428	0.84793	0.855836	0.855328	0.013542
$\eta = 3$	0.828806	0.826738	0.84577	0.853174	0.845338	-0.0093

Table 2.7b: Inequality Decomposition

	Northeast	South	Midwest	West	I_η^W	I_η^B	Total	Residual
$\eta = 1.5$	0.015817	0.015831	0.01005	0.009016	0.003574	-0.00589	0.012889	0.015204
$\eta = 2$	0.027475	0.026606	0.016321	0.015105	0.005999	0.002272	0.021673	0.013403
$\eta = 2.5$	0.027475	0.026606	0.016321	0.015105	0.007691	0.012019	0.027855	0.008144
$\eta = 3$	0.036384	0.034156	0.020258	0.019327	0.008909	0.023558	0.032331	-0.00014

Table 2.8b: Relative Contribution to Total Inequality

	I_η^W	I_η^B	Residual
$\eta = 1.5$	27.7%	-45.7%	118.0%
$\eta = 2$	27.7%	10.5%	61.8%
$\eta = 2.5$	27.6%	43.1%	29.2%
$\eta = 3$	27.6%	72.9%	-0.4%

Chapter 3

Accounting for Freedom and Economic Resources in the Assessment of Changes in Women Poverty in Sub-Saharan Africa[34]

[34] This chapter draws on the work of a joint research project with Prof. Paul Makdissi and Dr. Myra Yazbeck.

3.1 Introduction

Since the dawn of time, human beings have been fighting for their freedom. Some of the principal forms of freedom are: physical freedom, freedom of opinion, freedom of thought, political freedom, economic freedom, sexual freedom, freedom to live, freedom of association, freedom of belief, freedom of speech, freedom of the press, to name just a few. Sen (1999) sees freedom as the key to development. Freedom is the foundation of Sen's capability approach. The capability approach measures a person's well-being by focusing on the freedom the person has in choosing among a set of opportunities. The violation of one's freedom (Sen, 1992, p.87), the threat of domestic violence and domestic violence itself (Anand *et al.*, 2008) reduce a person capability. Agarwal and Panda (2007) show the importance of freedom from domestic violence for human development, especially for women's wellbeing. Anand *et al.* (2008) found that the threat of violence undermines women's wellbeing. These studies show the contribution of freedom to human wellbeing. Following this direction, this paper assesses the importance of freedom in women's wellbeing in Sub-Saharan Africa.

The opportunity and the process aspects of freedom are the two types of freedom described by Sen (1999, 2002, 2009). According to the opportunity aspect of freedom, "more freedom gives us more opportunity to achieve those things that we value and have reason to value" (Sen, 2002, p.585). This aspect of freedom concentrates on the individual's ability to achieve what she/he values. In the process aspect of freedom, "the process through which things happen may also be of importance in assessing freedom" (Sen, 2002, p.585). In other words, it is the freedom to choose by oneself without cohesion that is valuable. A reduction of ones opportunities inhibits one's opportunity aspect of freedom while the process aspect of freedom is undermined if one cannot decide by oneself what to do (Sen, 2009, p.228). The measurement of freedom remains problematic because of its intangibility. Sen (1989, 1992) acknowledges that the major limit of the application of the capability approach is data restrictions that force the analysts to only focus on achieved functionings rather than capabilities. Alkire (2007) gives an interesting empirical overview of

two approaches to measuring individual freedom: the empowerment measures and opportunity freedoms, and the agency measures. Foster (2011) presents three axiomatic methods of the measurement of the opportunity aspect of freedom: the cardinality method for the no preference ordering, the indirect utility approach for the single preference ordering and the effective freedom method for the plural preferences orderings. Unlike the previous authors, Makdissi *et al.* (2014) measure individual freedom by exploring the information on the threat of domestic violence to assess the extent of women's freedom. In addition, they contribute to the empirical literature of the capability approach by reconciling the capability approach and the process aspect of freedom since they measure Sub-Saharan Africa women's wellbeing with their access to economic resources and their freedom within their households. They propose stochastic dominance conditions that allows them to avoid making explicit judgment on the "value of freedoms" when identifying robust rankings of distributions of wellbeing.

The widespread agreement that poverty is essentially a multidimensional concept, has been accompanied by many types of multidimensional measures. We have measures such as the axiomatic approach (Tsui, 2002; Atkinson, 2003; Bourguignon and Chakravarty, 2003; Alkire and Foster, 2011a), the fuzzy set approach (Lemmi and Betti, 2006; Chiappero-Martinetti and Roche, 2009), latent variable approach (Kakwani and Silber, 2008; Asselin, 2009), distance function approach (Deutsch and Silber, 2005; Anderson *et al*., 2008; Ramos, 2008) and the information theory approach (Maasoumi and Lugo, 2008). This study focuses on the axiomatic approach.

This paper provides additional evidence on the multidimensionality of poverty by taking the same route as Makdissi *et al.* (2014) to measure individual freedom. However, it differ from Makdissi *et al.* (2014) in two respects. First, it focuses on poverty instead of welfare. It adopts the stochastic dominance approach to analyse the evolution of women's poverty over time in twelve countries of Sub-Saharan Africa by focusing on freedom and economic resources. Second, it applies the Shapley decomposition to determine the contributions of the economic resources distribution and the incidence of the threat of domestic violence to poverty changes over time.

The results obtained in the study support previous work on the importance of freedom. I find that more freedom, i.e. less threat of domestic violence, affects positively women's wellbeing since it decreases women's poverty. The results indicate that women's wellbeing has improved in Burkina Faso, Ghana, Kenya, Lesotho, Madagascar, Malawi, Rwanda, Senegal, and Zimbabwe and deteriorated in Ethiopia, Nigeria and Tanzania.

The remainder of the paper is structured as follows: Section 2 presents a literature review, Section 3 describes the theoretical framework for sequential stochastic dominance tests, Section 4 describes the data and provides descriptive statistics, Section 5 features the empirical results for poverty comparisons between two periods in each country and Section 6 concludes the paper.

3.2 Literature Review

This paper is related to three lines of research. The first line of research focuses on freedom and capability approach, while the second line investigates the multidimensionality of poverty and the third line concerns the sequential stochastic dominance.

3.2.1 Freedom and Capability Approach

According to Berlin (1958) there are two concepts of freedom: negative freedom and positive freedom. Negative freedom refers to the situation in which no person prevents another person from doing or being what he is able to do or to be. Negative freedom increases with less interference from others. A person enjoys positive freedom when she is a master of her own life i.e. responsible for her choices.[35] The cornerstone of development is freedom (Sen, 1999). Sen develops the capability approach to tackle the limit of the traditional welfare economic approach by answering to the following ethical question "Equality of

[35] "For example, if a person happens to be poor and hungry because of low real wages or unemployment, *without* his having been prevented (by the state or by some strong-armed individual or institution) from seeking a higher wage or finding employment, then the person's negative freedom may not have been, in any way, violated, even though his positive freedom from hunger is clearly compromised by circumstances" (Sen, 1988).

What" (Sen, 1980, 1982, 1992).[36] The traditional approach that Sen (2009) calls "resource-based lines of thinking," goes back to Rawls' primary goods approach. It measures an individual's well-being with the goods and services the individual consumes and the utility she derives from her consumption (Basu and Lopez-Calva, 2011). This approach also measures an individual's well-being with an individual's income since income can be used to estimate the amount of good and services an individual can afford. The major problem with this approach stems from the fact that it reduces well-being into a single dimension (income) by neglecting the other essential dimensions for which a market is missing such as freedom and security (Thorbecke, 2007).

In contrast to the resource-based approach, the capability approach measures a person's well-being by focusing on the freedom the person has to choose among a set of opportunities. The capability approach measures a person's wellbeing by her ability to do things that are important to her and to be what she wants. In other words, an individual's wellbeing is estimated by her capability to accomplish her doings and beings that constitute her functionings.[37] Sen (1992) defines the capability of a person as her freedom to achieve valuable functionings. Thus, the capability set can be defined as "a set of vectors of functionings, reflecting the person's freedom to lead one type of life or another (Sen, 1992, p.40)." The freedom to choose one's type of life reveals all the enjoyable opportunities that are available to an individual. Individual, social and environmental factors may affect an individual's capabilities. Besides individual capabilities (the ability to read, to be well-nourished and well-sheltered), we have social capabilities (the provision of health care, security and schooling by the government), external capabilities introduced by Foster and Handy (2008) as the capabilities obtained through the relationship with another person and,[38] relative capabilities mentioned by Agarwal and Panda (2007) concerning the capabilities of a woman relative to her spouse. The capability

[36] Sen (1992) argues that people differ from each other in internal characteristics (such as age, gender, general abilities, particular talents, proneness to illness, physical and mental abilities) and external characteristics (such as ownership of assets, social backgrounds, environmental predicaments, in inherited fortunes, in the natural and social environment in which we live). So, income equality may not be able to tackle inequality in our ability to do what we would value doing. "For example, equal incomes can still leave much inequality in our ability to do what we would value doing. A disabled person cannot function in the way an able-bodied person can, even if both have exactly the same income" (Sen, 1992).

[37] "The relevant functionings can vary from such elementary things as being adequately nourished, being in good health, avoiding escapable morbidity and premature mortality, etc., to more complex achievements such as being happy, having self-respect, taking part in the life of the community, and so on" (Sen, 1992).

[38] For example, a mother provides the capability to achieve good health to her baby since a baby alone does not have the ability to achieve a good health. In addition, an individual education may enrich the capabilities of her family and friends.

approach emphasizes freedom while the resource-based focuses on the means to freedom (Sen, 1992, p.84). It also covers a person's achieved functionings and all the other functionings that she is capable of achieving (Sen, 2009). This methodology derives the determinants of individual well-being and reveals multidimensionality of individual wellbeing, i.e. a person's wellbeing depends both on his market-based capabilities such as the necessary income to afford basics needs and non-market capabilities such as freedom to vote (Foster and Handy, 2008). It forms the basis of the following wellbeing and poverty measures: the Human Development Index (HDI), Gender-related Development Index and the Human Poverty Index (HPI).

The violation of one's freedom and "internal debilation" may decrease a person capability (Sen, 1992, p.87). The threat of domestic violence and domestic violence itself reduce the capability set (Anand *et al.*, 2008). According to Agarwal and Panda (2007), the freedom from domestic violence has a positive impact on women's wellbeing. They found that ownership of a house and land by women reduces marital violence.[39] Anand *et al.* (2008) use data from 2005 collected by a market research company (YOUGOV) which represents the adult population in mainland Britain to propose some subjective variables that they consider as capability indicators. They analyze the determinants of domestic violence considered as a measure of capability and estimate the impact capability variables on individual subjective well-being (life satisfaction). They found that the threat of violence undermines women's well-being. These studies show the utility of freedom in human wellbeing. Following this direction, this paper assesses the importance of freedom in women's wellbeing in Sub-Saharan Africa. Our results therefore confirm the findings of earlier studies, based on DHS data of twelve countries, which suggest that freedom affects positively women's wellbeing in Sub-Saharan Africa.

Sen (1999, 2002, 2009) distinguishes two aspects of freedom: the opportunity aspect of freedom and the process aspects of freedom. According to the opportunity aspect of freedom, "more freedom gives us more *opportunity* to achieve those things that we value and have reason to value" (Sen, 2002, p.585).

[39] "Immovable property provides a woman economic and physical security, enhances her self-esteem, and visibly signals the strength of her fall-back position and tangible exit option. It can both deter violence and provide an escape if violence occurs" (Agarwal and Panda, 2007).

This aspect of freedom concentrates on the individual's ability to achieve what she/he values.[40] In the process aspect of freedom, "the process through which things happen may also be of importance in assessing freedom" (Sen, 2002, p.585). In other words, it is the freedom to choose oneself that is valuable.[41] A large reduction of ones opportunities inhibits one's opportunity aspect of freedom while the process aspect of freedom is undermined if one cannot decide by oneself what to do (Sen, 2009, p.228). Sen (2002, p.596) sees the opportunity aspect of freedom as the "freedom to achieve" through one's own actions and those of others and the process aspect as the "freedom to act" which determines an individual's autonomy and her immunity from intrusion. The capability approach can be used to analyze the opportunity aspect of freedom but not the process aspect of freedom (Sen, 2009, p.371).

The measurement of freedom remains problematic because of its intangibility. Sen (1989, 1992) acknowledges that the major limit of the application of the capability approach is data restrictions that force the analysts to only focus on achieved functionings rather than capabilities. Alkire (2007) also recognizes the difficulty of measuring the opportunity aspect of freedom. She gives an interesting empirical overview of the following two approaches to measure individual freedom: the empowerment measures and opportunity freedoms and the agency measures. Foster (2011) presents the following three axiomatic methods of the measurement of the opportunity aspect of freedom: the cardinality method for the no preference ordering, the indirect utility approach for the single preference ordering and the effective freedom method for the plural preferences orderings. Makdissi *et al.* (2014) develop a bidimensional stochastic dominance test to compare distributions of women wellbeing in a context where economic resources and freedoms are accounted for. This bidimensional stochastic dominance test called the capability dominance focusses on both economic resources (consequence) and freedom (process).

This paper uses the approach proposed by Makdissi *et al.* (2014) and adapts it to poverty. This approach consists of reconciling the capability approach and the process aspect of freedom since they

[40] "More freedom helps, for example, in our ability to decide to live as we would like and to promote the ends that we may want to advance" (Sen, 2009, p.228).
[41] "We may for example, want to make sure that we are not forced into some state because of constraints imposed by others" (Sen, 2009, p.228).

measure women's wellbeing with their access to economic resources and their freedom within their households. The freedom set of an individual is identified by exploring the information on the threat of domestic violence. Since it considers two dimensions of wellbeing, the paper also relates to the literature on multidimensional poverty. In addition, it relates to the literature on sequential stochastic dominance because one of the dimensions, the freedom set, takes a limited number of discrete values. The next two subsections review these two literatures.

3.2.2 Multidimensional Poverty

The seminal work of Sen (1976) has offered the toolbox for poverty measurement which continues to be used widely. According to Sen, the poverty measurement first requires the identification of the poor and second, the creation of poverty indices. With this toolbox, researchers have long seen poverty as a lack of income or consumption. Although income can be used to satisfy some basic needs, it remains insufficient to satisfy basic needs that do not have markets or whose markets are imperfect such as public goods (Tsui, 2002; Bourguignon and Chakravarty, 2003). Another problem with the income approach is that the individual with income at or above the poverty line may not use it to satisfy the basic needs (Thorbecke, 2007).[42] Hence this income approach is not suitable enough for poverty measurement that takes into account the basic needs that may be monetary and non-monetary. To overcome the problem of income approach, the basic needs approach (Streeten, 1981) and the capability approach (Sen, 1985) have been proposed. They constitute the starting point of the multidimensional poverty approach. Sen's capability approach views poverty as a lack of ability (capability) to achieve some basic functionings (such as education, health, life expectancy and nutrition) to enjoy life. In this approach, the notion of freedom is very important since it characterizes the person's capabilities to accomplish a set of functionings (Sen, 1992). The major problem with this approach is the difficulty with measuring the inputs (capabilities) that represent the freedom, but

[42] "In fact there are numerous examples of household heads who receive an income above the poverty line and allocate it to satisfy wants for, say, alcohol and tobacco at the expense of satisfying the minimum caloric requirements of their children. In the money-metric approach such households would be classified as non-poor whereas in reality at least some of their members are deprived of some basic needs and therefore should be considered poor" (Thorbecke, 2007).

one can only measure the outputs (functionings). The social exclusion approach is another conception of poverty.[43] According to this approach, poverty is measured by the degree of economic, political and cultural participations in society (Wagle, 2008). These conceptions of poverty show that poverty is multidimensional.

Today, there is widespread agreement that poverty is multidimensional. However, the measurement of this multidimensionality differs from one author to another. In the literature, we have few types of multidimensional poverty measures such as the axiomatic approach (Tsui, 2002; Atkinson, 2003; Bourguignon and Chakravarty, 2003; Chakravarty and D'Ambrosio, 2006; Chakravarty and Silber, 2008; Bossert *et al.*, 2009; Alkire and Foster, 2011), the fuzzy set approach (Lemmi and Betti, 2006; Betti *et al.*, 2008; Chiappero-Martinetti and Roche, 2009), latent variable approach (Kakwani and Silber, 2008; Krishnakumar, 2008; Asselin, 2009), distance function approach (Deutsch and Silber, 2005; Anderson *et al*., 2008; Ramos, 2008) and the information theory approach (Maasoumi and Lugo, 2008).[44]

This study will focus on the axiomatic approach. The axiomatic approach is based on a set of assumptions that should be satisfied by the poverty index and it is appropriate for distribution rankings (Chakravarty and Silber, 2008). This approach can be divided in two broad strands. The first is concerned with the development of multidimensional indices (that allow complete orderings) following Bourguignon and Chakravarty (1999, 2003), Atkinson (2003), Alkire and Foster (2011). The second focusses on the development of stochastic dominance tests (that permit robust but incomplete orderings) following Duclos *et al.* (2006a, 2006b). The axiomatic approach proposed by Bourguignon and Chakravarty (2003) is an extension of the FGT indices to a multidimensional poverty measure based on shortfall of the attributes. They propose a bidimensional measure based on two continuous variables in which an individual is considered as poor if she is below the threshold of both attributes. If the two attributes are substitutes, the individual who is below the poverty line in one attribute, is considered poor if her level of the other attribute

[43] According to Nolan and Whelan (2007), pure caste society is good example of social exclusion since in this society, your cast determine your destiny.

[44] In the multidimensional approach of poverty, there is quite often the situation in which the status of an individual is ambiguous, i.e. one may classify the individual as poor according to certain conditions or non-poor according to another conditions. Chakravarty (2006) proposed an axiomatic approach for multidimensional poverty based on the fuzzy sets theory.

in which she is not poor, is not high enough to compensate for the shortage in the attribute in which she is poor. They found that the substitution between attributes leads to less reduction of poverty than complementarity between attributes. For example, a unit increase in income for individuals whose level of education are closed to the education poverty line, leads to a less decrease in poverty than for individuals with low level of education if income and education are substitutes. However, the reduction in poverty is higher for individuals highly educated if the attributes were complements. Empirically, the authors use the Brazil National Household Sample Survey (PNAD) data for the years 1981 and 1987 to illustrate their multidimensional poverty measure. They use income and educational level as their two dimensions. They found an increase in income poverty and a decrease in education poverty in their unidimensional measure but the results of their bidimensional measure depends on the weighting coefficients, the income and education level and the degree of substitutability between them. Atkinson (2003), on the other hand, shows how the counting approach can be used to satisfied dominance condition like the Bourguignon and Chakravarty (2003) welfare approach by taking into account the union and intersection identifications.[45] Duclos *et al.* (2006a, 2006b) proposed a bi-dimensional stochastic dominance test which provides a robust poverty ordering with respect to the poverty lines and many poverty indices. In their framework, the two dimensions are substitutes. Their measure differs from that of Bourguignon and Chakravarty (2003) by the fact that substitutability between attributes occurs through their poverty lines. In their study, they take into account sampling variability. Empirically, they found that the unidimensional dominances may be satisfied for all the dimensions while the multidimensional dominance is not respected and the reverse may also hold. This may be explained by the level of correlation between the dimensions. Thus, the population with highly correlated dimensions will be multidimensionally poorer than the one with lowly correlated dimensions.

[45]In the counting approach, an individual's poverty is measured by the number of attribute in which she is poor. In other words, this approach consists of counting the number of dimensions in which an individual is poor.
According to the union identification approach, a person is considered as poor if there is at least one attribute in which the person is deprived, while for the intersection approach, a person is said to be poor only if the person is deprived in all attributes.

Since the indicators of well-being are not only measured by continuous indicators such as income and consumption, Duclos *et al.* (2007) suggested a multidimensional poverty measure that includes discrete variables among its attributes. Along similar lines, Yalonetzky (2013) developed multidimensional stochastic dominance conditions for ordinal variables. Alkire and Foster (2011) extend the counting approach proposed by Atkinson (2003) by including FGT measure that takes into account the breadth, depth and severity of poverty. In their methodology, they propose a new way of identifying the poor called the "dual cutoff" which includes two types of poverty line. The first one is the poverty line in each dimension of poverty and the second is the minimum number of dimensions in which one has to be deprived to be considered as poor for equally weighted dimensions. Their measure also permits the decomposition by subgroup population and by dimension and accepts a large number of dimensions that may be ordinal, categorical, discrete, cardinal and continuous variables. Our analyses relates to the work of Duclos *et al.* (2007), who suggested a multidimensional poverty measure that includes discrete variables among its attributes. In their study, they focus on the following discrete variables: household size, adult literacy, area of residence, education status and health status. We differ from them since we concentrate on freedom as our discrete variable, which is a keystone of development according to Sen. This paper builds on Makdissi *et al.* (2014) but differs from it in a number of respects. First, we focus on poverty instead of welfare. Secondly, we apply the Shapley decomposition to determine the contributions of the economic resources distribution and the incidence of the threat of domestic violence to poverty changes over time.

3.2.3 Sequential Stochastic Dominance

Analysts have been confronted with several problems when using income distribution to measure poverty and welfare of different populations or the same populations across time. One of these difficulties concerns the choice of social welfare indices, poverty indices and poverty lines. These choices may affect the ranking of the distributions. For example, different social welfare indices, poverty indices or poverty lines may give different rankings of the distributions. To overcome this arbitrariness, analysts use stochastic dominance

criterion for both welfare comparison and for poverty comparison (Atkinson, 1987; Foster and Shorrocks, 1988a, b and c). However, the robustness of the stochastic dominance condition is only satisfied for the homogeneous populations' comparison. It does not hold when the analysis concerns heterogeneous populations, i.e. if the populations differ by characteristics or structures other than income such as households with different sizes, households with different composition and households with different energy needs. For example, households with a larger size may be needier than households with smaller size. The standard approach to tackle the heterogeneity of the population consists of using an equivalence scale to convert a household income (or consumption) into an equivalent income (consumption) of one person. Yet, the choice of the equivalence scale also suffers from arbitrariness.

An alternative approach to deal with the heterogeneous distribution is the sequential stochastic dominance approach suggested first by Atkinson and Bourguignon (1987) for welfare measurement of populations with the same demographic composition of households. Atkinson (1992) has also used the same technique to analyze poverty. This sequential stochastic dominance approach allows to identify robust welfare and poverty rankings. Jenkins and Lambert (1993) have proposed a new version of the sequential stochastic dominance technique. This technique leads to a robust ranking of populations with different proportion of households' types or different marginal distribution of needs. Chambaz and Maurin (1998) extended the same approach to the case in which the definition of poverty varied over time and they also derived the second order sequential stochastic dominance condition. Duclos and Makdissi (2005) developed the s-order sequential stochastic dominance that allowed a robust poverty orderings over large classes of equivalence scales, poverty lines and poverty indices. They also estimated the critical sets of measurement assumptions for a given poverty comparison instead of making the measurement assumptions first and then testing for the robust comparison. Following Duclos and Makdissi's (2005) technique, Makdissi and Wodon (2006) analysed fuel poverty in Guatemala among households with and without access to electricity.

For welfare analysis, a common weakness of sequential stochastic dominance criterion derived by Jenkins and Lambert (1993) and all his extended versions is that, one assumes that at the maximum level of income, the utility derived remains the same regardless of the household need (Bazen and Moyes, 2003).

Additionally, for poverty analysis, one assumes that at the maximum level income, there is no poverty regardless of household need. This assumption reduces the impact of the marginal distributions of needs in the ranking of distributions (Moyes, 2012).[46] Theoretically, this paper relates to the work of Moyes (2012), who focused on welfare comparisons based on ability, while we focus on poverty comparisons based on freedom.

3.3 Theoretical Framework

We consider a population $\mathcal{P} \coloneqq \{1,2,\dots,n\}$ of n individuals. Each individual is described by two attributes: economic resources (income, wealth,…) and a set of freedoms. These attributes constitute individual well-being. We assume that there exists a finite number of sets of freedom K, where $2 \leq K \leq n$. We denote by $\mathcal{L} \coloneqq \{L_1, L_2, \dots, L_K\}$ the collection of all possible sets of freedoms. We assume that $L_1 \subseteq L_2 \subseteq \cdots \subseteq L_K$ with L_K is considered as a set of freedom with no deprivation. Individual *i*'s economic resources are represented by $x_i \in \mathcal{D} \coloneqq [\underline{x}, \overline{x}] \subset \mathbb{R}$. Individual *i*'s set of freedoms is represented by $l_i \in \mathcal{L}$.

We assume that each individual uses her economic resources within the limit of her freedoms to achieve some social functionings.[47] Sen (1992) defines the capability of an individual as the various functionings that this person can achieve. Capability is a set of functionings, showing the freedom of a person to shape her own life (Sen, 1992). Sen (1992, p.31) argues that "a person's position in a social arrangement can be judged in two different perspectives, viz. (1) the actual achievement, and (2) the freedom to achieve."[48] We make the assumption that individual *i*'s freedom to achieve is determined by her economic resources and her set of freedoms. Formally, we assume the distribution of capabilities in a population is represented by the joint distribution of economic resources and freedoms:

[46] They give the following example: "Suppose that there are only two types: single adults and households composed of two adults. Consider two societies *S*1 and *S*2 such that the distributions of income for each type are identical in both situations and such that there are twice as many couples and half as many singles in society *S*1 than in society *S*2. Then, the application of the Jenkins and Lambert [23] criterion indicates that societies *S*1 and *S*2 have the same living standards, while one intuitively expects that *S*2 would dominate *S*1."

[47] "The relevant functionings can vary from such elementary things as being adequately nourished, being in good health, avoiding escapable morbidity and premature mortality, etc., to more complex achievements such as being happy, having self-respect, taking part in the life of the community, and so on" (Sen, 1992, p.39).

[48] "Achievement is concerned with what we *manage* to accomplish, and freedom with the *real opportunity* that we have to accomplish what we value" (Sen, 1992, p.39).

$$c \equiv (x; l) \coloneqq \begin{bmatrix} x_1 & l_1 \\ \vdots & \vdots \\ x_i & l_i \\ \vdots & \vdots \\ x_n & l_n \end{bmatrix}, \quad (3.1)$$

Where $c_i = (x_i, l_i)$ is the capability set of an individual *i*.

It is worth mentioning that public policy may alter both economic resources (economic policy) and freedoms (legal framework and public education on social, gender and religious norms). We consider, Ω^s, as a class of additive poverty indices that obey some s-order ethical assumptions. In order to determine if poverty has decreased from time A to time B in a given country, let the joint cumulative distribution, $F_A(x, L_k)$ associated with the distribution of capabilities c^A, indicate the proportion of individuals whose freedom set is L_k and whose economic resources does not exceed *x* in time A. The associated marginal distribution of economic resources is given by $F_A(x, L_K)$ while $F_A(\overline{x}, L_k)$ indicates the marginal distribution of freedom and $F_A(x|L_k)$ is the conditional distribution of economic resources. Let θ_{Ak} be the proportion of individuals with freedom set L_k. $F_B(x, L_k)$, $F_B(x, L_K)$, $F_B(\overline{x}, L_k)$, $F_B(x|L_k)$ and θ_{Bk} are all defined analogously.

Now let the individuals with freedom set L_k stochastic dominance curves be defined as $D_A^1(x|L_k) = F_A(x|L_k)$ and $D_A^s(x|L_k) = \int_{\underline{x}}^{\overline{x}} D_A^{s-1}(u|L_k)du$ for all integers $s \geq 2$. Following Davidson and Duclos (2000), we have

$$D_A^s(x|L_k) = \frac{1}{(s-1)!} \int_{\underline{x}}^{\overline{x}} (x-u)^{s-1}\, dF_A(u|L_k), \quad (3.2)$$

This equation is a particular type of the FGT indices which are additively decomposable and suitable for dominance curves.

Let $\Gamma_A^s(x, L_k)$ denote the contribution to total poverty of the individuals belonging to the *k* sets of freedom,

$$\Gamma_A^s(x, L_k) = \sum_{j=1}^{k} \theta_{Aj}\, D_A^s\big(x\big|L_j\big), \quad (3.3)$$

We assume that all the poverty indices *P* belonging to the class Ω^s are additive, we can write

$$P_A = \sum_{k=1}^{K} \theta_{Ak} \int_{\underline{x}}^{\overline{x}} p(x, L_k)\, dF(x|L_k), \quad (3.4)$$

The function $p(x, L_k)$ is the contribution of individual with economic resources *x* and freedom set L_k to aggregate poverty.

$$p(x, L_k) \begin{cases} = \lambda_k & for\ x \geq z_k \\ \geq \lambda_k & for\ x < z_k \end{cases}, \quad (3.5)$$

where

$$\lambda_k \begin{cases} = 0 & if\ k = K \\ \geq 0 & if\ k < K \end{cases}, \quad (3.6)$$

λ_k is the minimum level of deprivation of an individual with freedom L_k

z_k is the poverty line of an individual with freedom L_k

and $(x, L_k) = 0\ if\ x = \overline{x}\ and\ L_k = L_K$.

Now we consider the classes of additive poverty indices Ω^s with $P \in \Omega^s$ such that:

$$\Omega^s = \left\{ P \middle| \begin{matrix} p(x,L_k) \in C^s \\ (-1)^i p^{(i)}(x,L_k) \geq 0 \\ p^{(t)}(\overline{x}, L_K) = 0 \qquad for\ t = 0,1, \dots, s-2 \end{matrix} \qquad for\ i = 0,1, \dots, s \right\}, \quad (3.7)$$

If poverty decreases when we move from time A to time B, we have

$$\Delta P_{AB} = P_A - P_B \geq 0, \quad (3.8)$$

For s-order stochastic dominance, we assume that $p(x, L_k) \in C^s$, where C^s is the set of function which are at least s-time differentiable over $[\underline{x}, \overline{x}]$.

In order to develop sequential stochastic dominance criteria we finally assume that:

$$p(x, L_k) \geq p(x, L_{k+1}), \qquad \forall\ x \in \mathcal{D}\ and\ \forall\ L_k = L_1, L_2, \dots, L_{K-1}, \quad (A1)$$

This means that poverty is increasing with less freedom. In other words, with the same economic resources, an individual with less freedom is poorer than an individual with more freedom. This assumption says with an equal economic resources, individuals with freedom set L_1 are more deprived than individuals with freedom set L_2, who are more deprived than individuals with freedom set L_3, and so on.

$$(-1)^s p^{(s)}(x, L_1) \geq (-1)^s p^{(s)}(x, L_2) \geq \cdots \geq (-1)^s p^{(s)}(x, L_K) \geq 0, \quad (A2)$$

When $s = 1$, it implies that an increase in individual economic resources *x* diminishes poverty regardless of her set of freedom. It also says that, for a given economic resources *x*, poverty reduction is greater for an individual with less freedom. This implies that poverty indices obey Makdissi *et al.*'s (2014) Generalized Weak Equity Principle of order 1. This principle is an adaptation of Sen's weak equity axiom (see Sen, 1992, p. 18) that reads as follows: "Let person *i* have a lower level of welfare than person *j* for each level of individual income. Then in distributing a given total of income among n individuals including *i* and *j*, the optimal solution must give *i* a higher level of income than *j*.". In our context, this principles is illustrated in Figure 3.1. It represents a weak progressive transfer of economic resources. It postulates that a transfer δ of economic resources from a person *j* to a person *i* such that $x_i^0 = x_j^0,\ x_i^1 = x_i^0 + \delta > x_j^1 = x_j^0 - \delta$ and $l_i^0 = l_i^1 < l_j^0 = l_j^1$, constitutes a poverty reduction. The poverty reduction is then higher for the individual with less freedom.

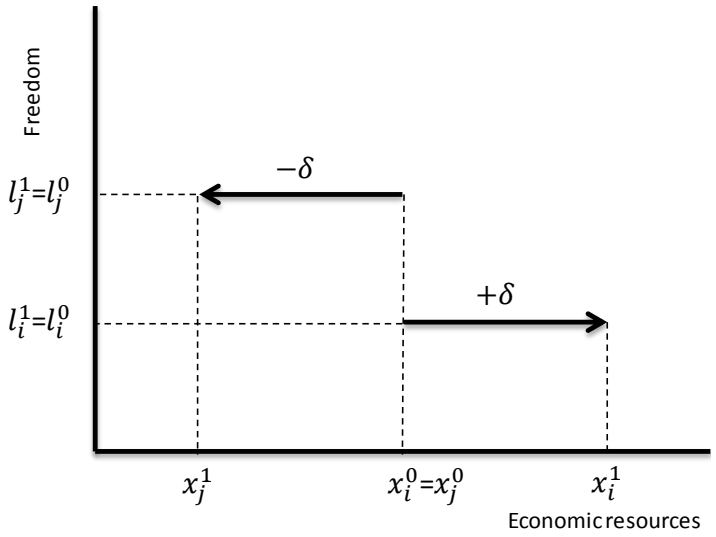

Figure 3.1: A Weak Progressive Transfer of Economic Resources

When $s = 2$, it implies that the indices obey the Pigou–Dalton principle of transfers. It postulates that mean-preserving transfers of economic resources from a person with higher economic resources to a person with lower economic resources decreases poverty. This effect is stronger for individuals with less freedom. In this sense, poverty indices are said to obey Makdissi *et al.*'s (2014) Generalized Weak Equity

Principle of order 2. This principle is illustrated in Figure 3.2. It represents a weak progressive composite transfer of economic resources. It stipulates that a transfer δ of economic resources from a person *k* to a person *i* (such that $x_i^0 = x_k^0,\ x_i^1 = x_i^0 + \delta > x_k^1 = x_k^0 - \delta$ and $l_i^0 = l_i^1 < l_k^0 = l_k^1$) would be preferred to the same transfer from a person *j* to the person *m* (such that $x_j^0 = x_m^0,\ x_m^1 = x_m^0 + \delta > x_j^1 = x_j^0 - \delta$ and $l_j^0 = l_j^1 < l_m^0 = l_m^1$). This implies that a weak progressive transfer of economic resources between person *i* and person *k* will more than compensate for a weak regressive transfer of economic resources between person *j* and person *m* because person *j* and person *m* have higher economic resources and the poverty reduction is stronger for individuals with less freedom. A weak progressive composite transfer of economic resources can be interpreted as a combination of a weak progressive transfer of economic resources and a weak regressive transfer of economic resources. The Generalized Weak Equity Principle of order 2 is a combination of favourable Generalized Weak Equity Principle of order 1 at a lower level of freedoms and an unfavourable Generalized Weak Equity Principle of order 1 at a higher level of freedoms.

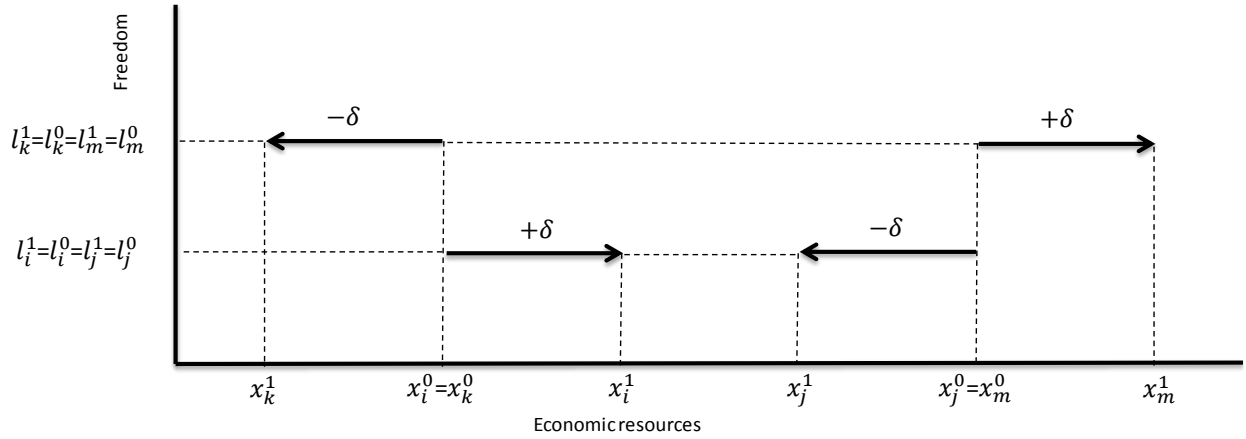

Figure 3.2: A Weak Progressive Composite Transfer of Economic Resources

When $s = 3$, it implies that the indices obey the transfer-sensitivity principle. This favorable composite transfer is due to a beneficial Pigou-Dalton transfer within a lower part of the distribution, combined with a reverse Pigou-Dalton transfer within an upper part of the distribution. This will lead to the decrease of third order poverty indices if the variance of the distribution has not increased. The indices also obey Makdissi *et al.*'s (2014) Generalized Weak Equity Principle of order 3. This principle is illustrated in

Figure 3.3. It can be interpreted as a combination of a weak progressive composite transfer of economic resources occurring at lower level of freedoms (i.e. from person j to person *i* and from person *k* to person *m*) and a weak regressive composite transfer of economic resources at level of freedoms (i.e. from person *p* to person *q* and from person *u* to person *r*). The Generalized Weak Equity Principle of order 3 is a combination of favourable Generalized Weak Equity Principle of order 2 at a lower level of freedoms and an unfavourable Generalized Weak Equity Principle of order 2 at a higher level of freedoms.

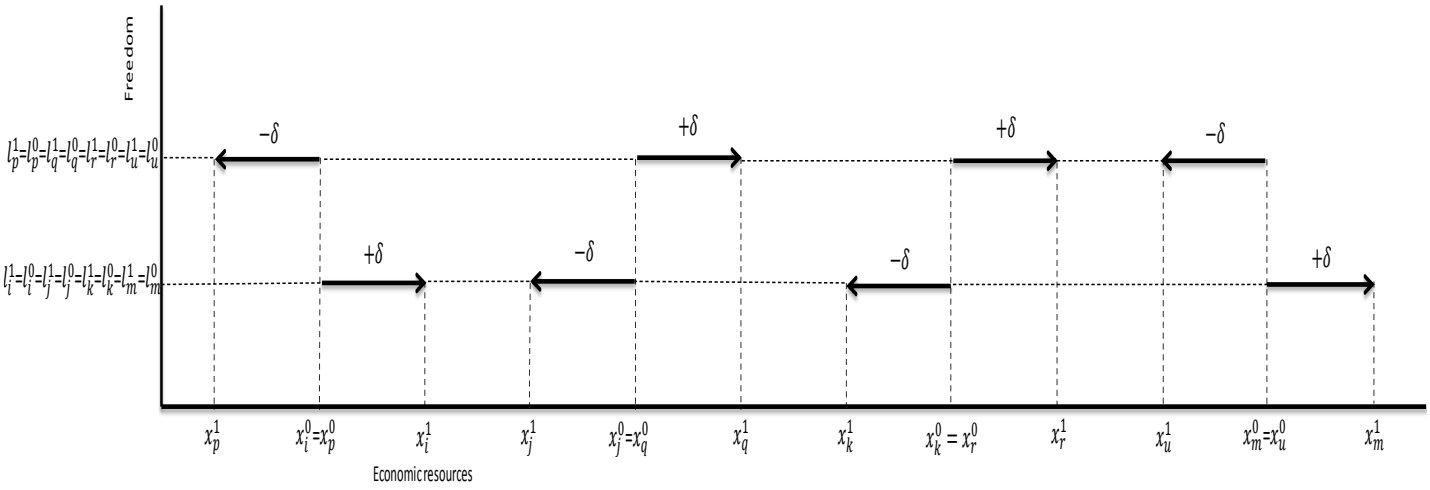

Figure 3.3: A Weak Progressive Generalized Transfer of Economic Resources

We assume that the individuals with less freedom have higher poverty lines.

$$\overline{x} \geq z_1 \geq z_2 \geq \cdots \geq z_K, \quad (A3)$$

Let z_k^+ be the maximum possible poverty line for the individuals with freedom set L_k with $z_k \leq z_k^+, \forall k = 1,2,\ldots,K$. This leads to:

$$\overline{x} \geq z_1^+ \geq z_2^+ \geq \cdots \geq z_K^+$$

Now, we describe the ethical principles that present the interrelations between the freedom and the economic resources.

Proposition 1

$\Delta P_{AB} \geq 0$ for all P satisfying (A1) and (A2) and for all poverty lines $z_k \in [0,\ z_k^+]$, $k = 1, 2, \ldots, K$, if and only if $\Gamma_A^s(x, L_k) \geq \Gamma_B^s(x, L_k),\ \forall x \leq\ z_k^+, \forall\ k.\ \forall x \in \mathcal{D}$. (Proof in Appendix 3.A)

One can say that poverty has decreased from time A to time B in a given country if and only if all $\Gamma_A^s(x, L_k)$ lies everywhere over $\Gamma_B^s(x, L_k)$ (or $\Gamma_A^s(x, L_k) \geq \Gamma_B^s(x, L_k)$) up to the maximum poverty line z_k^+. We assume that we have two sets of freedom: L_1 and L_2, where L_1 is the restricted freedom set and L_2 is the non-restricted freedom set. If $\Gamma_A^1(x, L_1)$ lies everywhere over $\Gamma_B^1(x, L_1)$ up to the maximum poverty line z_1^+, then poverty has decreased among the individuals with a restricted freedom set. $\Gamma_A^1(x, L_1)$ and $\Gamma_B^1(x, L_1)$ represent the cumulative distribution of economic resources among the individuals with a restricted freedom set for time A and time B. If $\Gamma_A^1(x, L_2)$ lies everywhere over $\Gamma_B^1(x, L_2)$ up to the maximum poverty line z_1^+, then poverty has decreased for the entire population from time A to time B since $\Gamma_A^1(x, L_2)$ and $\Gamma_B^1(x, L_2)$ are respectively the cumulative distribution of economic resources for the entire population (both the individuals with restricted non-restricted freedom sets). We can then conclude that there is a robust dominance. With the generalized weak equity of order (*s*,1), a loss for an individual with freedom set L_2 may be compensated by a gain for an individual with freedom set L_1 at the same level of economic resources.

If the stochastic dominance test has failed ($\Gamma_A^s(x, L_k) \not\geq \Gamma_B^s(x, L_k)$), we cannot infer that there is a robust poverty ordering over the specified set of poverty indices and poverty line upper bound z_k^+. There are two alternatives to finding a robust poverty ordering. The first consists of increasing the order of dominance until a robust poverty ordering is obtained over the initially specified range $[0,\ z_k^+]$. The second consists of estimating an upper critical bound z_k^s for a range$[0,\ z_k^s]$ of poverty lines that does not exceed z_k^+.

Empirically, to determine whether poverty is unambiguously higher in period *A* than in period *B*, we can initially test for first order (s=1) sequential stochastic dominance. If $\Gamma_A^1(x, L_k) \not\geq \Gamma_B^1(x, L_k)$, we conclude that the poverty ordering of the two distributions is not robust over Ω^1 (a class of additive poverty

indices) and over the pre-specified ranges of poverty lines determined by $z_1^s, z_2^s, \dots, z_K^s$. We then continue to test the other orders. In the absence of robust ordering, we can search for a critical z_1^+ such that z_1^+ is the maximum value of x which obeys the condition $\Gamma_A^s(x, L_k) \geq \Gamma_B^s(x, L_k)$. This will limit the values of $z_2^+, z_3^+, \dots, z_K^+$ without necessarily reducing z_1^+.

Let $\hat{z}_k^s$ be the estimate of z_k^s. This gives a set of upper poverty line bounds $z_1^s, z_2^s, \dots, z_K^s$, that may not obey the assumption made on the ranking of z_k^+. To ensure that $z_k^s \geq z_{k+1}^s$, we proceed by iteration. First, we find $z_1^s = \hat{z}_1^s$ and then we set the remaining z_k^s as $z_k^s = min(\hat{z}_k^s, z_{k-1}^s)$, for $k = 1,2, \dots, K$.

Shapley Decomposition

The Shapley decomposition approach consists of estimating the marginal effect of each component as they are eliminated in succession, and then averaging these marginal effects over all the possible elimination sequences (Shorrocks, 2013). The advantages of this procedure are the following: it treats the components of poverty variation symmetrically. It does not leave any residual terms in the poverty measure and the contribution of each component can be inferred as its marginal effect (Shorrocks, 2013). The Shapley decomposition will help us to clearly determine the contributions of the economic resources distribution and the incidence of the threat of domestic violence to poverty changes over time. This change of poverty over time may be explained by the change in the incidence of the threat of domestic violence or by the change in the economic resources distribution or by both.

The impact of the change in the incidence of the threat of domestic violence is given by:

$$C_\theta = \frac{1}{2}\sum_{k=1}^{K}(\theta_{Ak} - \theta_{Bk})\left(D_A^s(x|L_k) + D_B^s(x|L_k)\right) \qquad \forall x \in [\underline{x}, \overline{x}], \forall k = 1,2, \dots, K \quad (3.9)$$

The impact of the change in the economic resources distribution is given by:

$$C_D = \frac{1}{2}\sum_{k=1}^{K}(\theta_{Ak} + \theta_{Bk})\left(D_A^s(x|L_k) - D_B^s(x|L_k)\right) \qquad \forall x \in [\underline{x}, \overline{x}], \forall k = 1,2, \dots, K \quad (3.10)$$

3.4 The Data

This study uses data from Demographic and Health Surveys (DHS) that are nationally-representative household surveys. DHS collect data that helps policy makers in their decision about population, health education and nutrition. DHS cover a household questionnaire, a women's questionnaire and a men's questionnaire. Most of the individuals interviewed in DHS consists of women of reproductive age (15-49) and men aged (15-59), or in some cases (15-54). DHS do not collect data on income or expenditures but they provide information on economic status and freedom status of the women who constitute our unit of analysis.

The first measure of well-being, i.e. the economic status is represented by the household wealth index that we consider as the economic resources. The variable wealth index was introduced to DHS around the end of the 90's. The wealth index is calculated by using a principal components analysis to data collected on household's ownership of a number assets such as televisions and car; materials used for housing construction; and types of drinking water sources, sanitation facilities and other characteristics that are related to wealth status. The wealth index is used to analyze many indicators of wellbeing, inter alia, health, nutrition and education (Rutstein, 2008).[49] It describes a permanent socioeconomic status compared to income or consumption (Filmer and Pritchett, 2001; Rutstein and Johnson, 2004). The wealth index is suitable for our study because we focus on women in developing countries, in particular, Sub Saharan Africa where data on income, consumption or expenditures are difficult to collect. We can interpret the wealth index as an indicator of the capacity of a woman to achieve a certain social functioning, contingent to her freedom.

The second measure of wellbeing, the freedom status of the women within the household, is measured by using data on the threat of domestic violence within the household. This point is also stressed by Agarwal and Panda (2007). They argue that domestic violence negatively affects all the following five instrumental freedoms enumerated by Sen (1999, p.38): political freedoms, economic facilities, social

[49] The World Bank uses the wealth index for its policy and program recommendations (Rutstein, 2008).

opportunities, transparency guarantees, and protective security. We derived information regarding women's individual freedom through the following questions. *In your opinion, is a husband justified in hitting or beating his wife in the following situations* (1) *If she goes out without telling her husband?* (2) *If she neglects the children?* (3) *If she argues with him?* (4) *If she refuses to have sex with him?* (5) *If she burns the food?* The respondents choose between three possible answers: (*i*) no, (*ii*) yes or (*iii*) don't know. These questions are being asked of married and unmarried women. As one can see, these questions cover many dimensions of individual freedoms starting from freedom in the personal sphere to freedom in the social sphere**.**

We recognize that our measure of freedom is subjective since it is based on self-reported data. Subjective data raises some doubts regarding its validity among economists. Subjective data may be biased or noisy. Subjective measures may be sensitive to the ordering of questions, the wording of questions, the response scales and, the social desirability and instability attitudes of the respondents (Bertrand and Mullainathan, 2001). In addition, the answers to the subjective questions depends on the personality and the mood of the respondents and, the conditions (the day or the time) under which the respondents is interviewed (Ravallion, 2012). Then, those problems may generate a measurement error and endogeneity problem in a regression analysis. In this paper, we believe that we are not affected by those problems related to regression analysis since we use the stochastic dominance approach.

The empirical application will use DHS for twelve Sub-Saharan Africa countries: Burkina Faso, Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Nigeria, Rwanda, Senegal, Tanzania and Zimbabwe. The years in which the DHS data is collected is not the same across countries. In our empirical illustration for each country we will focus on two points in time t and $t + m$. We choose the last two periods of surveys of each country because data on the threat of domestic violence exist only for those two periods on the two-third of the countries.[50] The years of surveys differ from one country to another. Table 3.1 provides information on the countries we are focusing, the years in which we observe the information as well as the number of observation for each of these years.

[50] Ethiopia, Malawi, Rwanda and Zimbabwe are the countries that have three surveys with data on the threat of domestic violence.

We assume that one can order the threat of domestic violence, i.e. the woman freedom status. We consider two approaches: the standard approach and the extended approach. The standard approach is based on two sets of freedom: L_1 is the freedom set characterized by any threat of domestic violence and L_2 is the freedom set characterized by no threat of domestic violence. The extended approach is based on four different sets of freedoms. The first set of freedom, L_1, is the worst level of freedom and is characterized by the threat of domestic violence when the woman refuses to have sex or argues. We consider that there is unfreedom in the personal sphere. The second set of freedom, L_2, is the middle level of freedom and is characterized by the threat of domestic violence when the woman neglects the children or burns food. There is unfreedom in the household physical sphere. The third set of freedom, L_3, is the light level of freedom and is characterized by the threat of domestic violence when the woman goes out without telling him. There is unfreedom in the social sphere. The last set of freedom, L_4, is the best level of freedom and is characterized by no threat of domestic violence. Note if a woman is included in L_1 she will not be included in L_2 and L_3 even if the answers are positive to the questions. The underlying assumption is that her set of freedoms in L_1 is more restricted than in L_2 and L_3.

After considering all the respondents that answer to at least one of the question on the threat of domestic violence which constitute with the asset index (economic resources) our main control variables, the final sample of the 2003 survey contains 12,005 observations. We have excluded 472 observations which represent 3.78% of the original sample (12,477 observations). In order to verify if there are differences in characteristics between the excluded observations and the non-excluded observations (as it is done in attrition detection), we conduct a probit regression analysis. We create a dichotomous variable with 1 representing the non-excluded observations and 0 representing the excluded observations. We regress the dichotomous variable on the following key demographic variables: age, region, education and the asset index (economic resources). There is a difference between the excluded and the non-excluded when one of the coefficients is statistically significant. The marginal effects for the estimates are represented in Table 3.4. We find that the coefficients of age and some of the regions dummies are statistically

significant but economically unimportant;[51] while the coefficients of education dummies and asset index (economic resources) are statistically not significant. This means that is a difference between the excluded and the non-excluded observations in age and region variables but not in education and asset index variables. For the 2010 survey, the non-excluded consists of 16,994 observations and the excluded consists of 92 observations (0.54% of the original sample). In this survey, we focus only on age and asset index as our explanatory variables since some region and education dummies variables perfectly predict the dichotomous variable (dependent variable). From Table 3.5, we find that the coefficients of age is statistically significant but economically unimportant;[52] while the coefficient of asset index (economic resources) is statistically not significant. We infer that there is a difference between the excluded and the non-excluded observations in age variable but not in asset index variable. We can conclude that the differences between the excluded observations and the non-excluded observations are negligible in 2003 and 2010 surveys. We notice the same situation in surveys of the other countries (see Table 3.6 to Table 3.27).

We apply the sampling weights to make the samples nationally representative. We use those data to illustrate the sequential stochastic dominance with freedom (a discrete variable). Table 3.2 reports the summary statistics by country after considering all the respondents that answer to our main variables. It presents the number of women by country and by year of the survey, the proportion of women in each freedom set and the economic resources. For example, in the 2003 Burkina Faso survey, we have 12,005 women with 64.65% in freedom set L_1(worst level of freedom) and 24.16% in freedom set L_4(freedom set with no threat of domestic violence); while in 2010, we have 16,994 women with 33.76% in freedom set L_1 and 56.9% in freedom set L_4. Table 3.3 presents the twelve countries that we cover in our study and the year of domestic violence legislation. Only six countries, i.e. 50% of the countries, have enacted domestic violence legislation.

[51] For example, a 1 percent increase in age is associated with a 0.001 percent increase in the probability that an observation will not be excluded in the sample, which is economically very small.
[52] A 1 percent increase in age is associated with a 0.0003 percent increase in the probability that an observation will not be excluded in the sample, which is economically very small.

3.5 Empirical Results

For each approach and in each country we apply the sequential stochastic dominance and the Shapley decomposition. Each table give the s-order dominance threshold $\widehat{z_k^s}$ for which time $t + m$ dominates (or dominated by) time t in each country. When $t + m$ dominates t, there is a decrease in poverty and when $t + m$ is dominated by t, there is an increase in poverty. Let give the meaning of the following letters that are in the results tables. The letter *p* means that $\widehat{z_k^s}$ goes to positive infinity (decrease in poverty from t to $t + m$). The letter *n* means that $\widehat{z_k^s}$ tends towards negative infinity (increase in poverty from t to $t + m$). The letter *pn* indicates that time $t + m$ initially dominates time t while the letter *np* indicates that time $t + m$ is initially dominated by time t.

Firstly, we will focus on the standard and extended approaches of the sequential stochastic dominance techniques. The standard approach of the sequential stochastic dominance results are presented in Table 3.28a to Table 3.39a. Table 3.28a shows the estimated threshold $\widehat{z_k^s}$ of Burkina Faso for sequential stochastic dominance test of order 1, 2 and 3. There is no specific critical poverty line for the deprived group since $\widehat{z_1^s}$ goes to positive infinity. The first column of Table 3.28a provides the values $\widehat{z_k^1}$ under which there is dominance of 2008 over 2003 (poverty reduction). The other columns provide the values for higher orders of dominance. For s=2, we can say that poverty has decreased for the group deprived of their freedom from 2003 to 2008 in Burkina Faso for any poverty indices belonging to class Ω^2 and for any poverty lines. We can also say that poverty has decreased for the entire population from 2003 to 2008 in Burkina Faso for any poverty indices belonging to class Ω^2 and satisfying the assumptions A1, A2 and A3, and up to the critical threshold $\widehat{z_2^2}$ =3.6401483 which constitutes 83.0568% of 2003 population and 87.5519% of 2008 population. We can conclude that women's poverty has decreased in Burkina Faso from 2003 to 2008. Similarly, the women's poverty has decreased in Ghana, Kenya, Lesotho, Malawi and Zimbabwe.[53] Table

[53] See Table 3.30, Table 3.31, Table 3.32, Table 3.34 and Table 3.39.

3.36a shows the estimated threshold $\widehat{z_k^s}$ of Rwanda for sequential stochastic dominance test of order 1, 2 and 3. To be able to say that poverty has decreased in Rwanda from 2005 to 2010 for any of the poverty indices belonging to class Ω^1 and for all sets of freedom, we should fix $z_2^+=\widehat{z_1^1}$=0.92534569 (48.4145% of 2005 population and 38.6804% of 2010 population). For classes Ω^2 and Ω^3, we should have $z_2^+=\widehat{z_1^2}$=1.6756141 (70.0645% of 2005 population and 82.2398% of 2010 population) and $z_2^+=\widehat{z_1^3}$=2.675972 (78.7828% of 2005 population and 90.5493% of 2010 population) respectively. In line with the results of Rwanda, there is a reduction in women's poverty in Senegal and Madagascar.[54] From Table 3.29a, we can say that poverty has increased in Ethiopia from 2005 to 2011 for any of the poverty indices belonging to class Ω^1 and for all sets of freedom by fixing $z_2^+=\widehat{z_1^1}$=0.94328466 (35.1457% of 2005 population and 39.9516% of 2011 population). For classes Ω^2 and Ω^3, we should fix $z_2^+=\widehat{z_1^2}$=1.0416525 (57.4627% of 2005 population and 54.8532% of 2011 population) and $z_2^+=\widehat{z_1^3}$=1.1540728 (67.3845% of 2005 population and 63.0760% of 2011 population) respectively. There is a restricted dominance regardless of the class of poverty indices with an increase in poverty. Along similar lines, there is an increase in women's poverty in Nigeria and Tanzania.[55]

The extended approach of the sequential stochastic dominance results are presented in Table 3.28b to Table 3.39b. For Ghana, an increase in the order of dominance produces a robust ordering among the deprived groups since the critical thresholds are not bounded. We find a robust ordering among the deprived groups regardless the order of dominance in Burkina Faso, Kenya, Lesotho, Malawi and Zimbabwe. Those results confirm the ones found in the standard approach about the reduction of poverty. For Madagascar, Senegal and Rwanda, there is a restricted dominance regardless of the class of poverty indices with an increase in poverty. In contrast to other countries, there is a restricted dominance regardless of the class of poverty indices for Ethiopia, Nigeria and Tanzania, with an increase in poverty.

[54] See Table 3.33, Table 3.37. Increasing the order of dominance produces a robust ordering since the critical thresholds are not bounded in Madagascar.
[55] See Table 3.35 and Table 3.38.

Secondly, we will discuss the results of the Shapley decomposition that will help us to check if the sequential dominance is partly due to differences in the economic resources distribution or partly due to the changes in the proportion of individuals in the freedom sets. The critical thresholds explained by the change in the incidence of the threat of domestic violence of the standard and the extended approaches are reported on Table 3.40a to Table 3.51a and Table 3.40b to Table 3.51b respectively. Table 3.40a and Table 3.40b shows that the critical thresholds in Burkina Faso, explained by the change in the incidence of the threat of domestic violence, are unbounded for the standard and the extended approaches. In other words, the change in the incidence of the threat of domestic violence (reduction of the threat of domestic violence) leads to an unambiguous decrease in poverty (unrestricted dominance) because all the critical thresholds are unbounded. Therefore, there is an increase in welfare. The same explanation holds for Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Rwanda, Senegal and Zimbabwe. Unlike the other countries, for Madagascar and Rwanda, the change in the incidence of the threat of domestic violence (increase in the threat domestic violence) leads to an unambiguous increase in poverty because all the critical thresholds are unbounded. Therefore, there is a decrease in welfare in these two countries.

The critical thresholds explained by the change in change in the economic resources of the standard and the extended approaches are reported on Table 3.52a to Table 3.63a and Table 3.52b to Table 3.63b respectively. The change in economic resources distribution leads to restricted dominance with a decrease in poverty compared to the change in the incidence of threat of domestic violence which leads to an unrestricted dominance in the following countries: Burkina Faso, Ghana, Kenya, Lesotho, Malawi, Senegal and Zimbabwe. We can conclude that the decrease in the threat of domestic violence highly contributes to the decrease in poverty in the aforementioned countries. The change of the economic resources distribution leads to a restricted dominance for Rwanda and an unrestricted dominance for Madagascar with a decrease in poverty while the change in the incidence of the threat of domestic violence leads to an increase in poverty. We can infer that the increase in the economic resources is the only contributor to the poverty reduction in both countries. For Ethiopia, Nigeria and Tanzania, we can deduce that the decrease in the economic resources highly contributes to the increase in poverty since the evolution economic resources

distribution leads to restricted and unrestricted dominances with an increase in poverty. The decrease in the incidence of the threat of domestic violence is offset by the decrease in economic resources in these countries.

3.6 Conclusion

In this paper, we assess the importance of freedom in women's wellbeing in twelve Sub-Saharan Africa countries, with only six that have enacted domestic violence legislation, by using the DHS. This study is related to the following three pieces of literature: the sequential stochastic dominance, the multidimensional poverty, the Sen's capability approach which is based on freedom. For the sequential stochastic dominance, our analyses follow the work of Moyes (2012) and Makdissi *et al.* (2014) who focused on welfare comparisons, while we focus on poverty comparisons. In the multidimensional poverty literature, our study is closely related to Duclos *et al.* (2007). We differ from them since we concentrate on freedom as our discrete variable, which is a keystone of development according to Sen. In addition, we apply the Shapley decomposition to determine the contributions of the economic resources distribution and the incidence of the threat of domestic violence to poverty changes over time. This paper uses the approach proposed by Makdissi *et al.* (2014) and adopts it to poverty. This approach consists of reconciling the capability approach and the process aspect of freedom, which Sen himself thought impossible, since they measure women's wellbeing with their access to economic resources and their freedom within their households.

Consistent with previous work on the importance of freedom, we find that more freedom, i.e. less threat of domestic violence, affects positively women's wellbeing since it decreases women's poverty. We find that women's wellbeing has been improved in Burkina Faso, Ghana, Kenya, Lesotho, Madagascar, Malawi, Rwanda, Senegal, and Zimbabwe and deteriorated in Ethiopia, Nigeria and Tanzania. The results of the Shapley decomposition show that the increase in economic resources is the only contributor to the reduction of poverty in Madagascar and Rwanda since there is an increase in the threat domestic violence.

However, the increase in poverty in Ethiopia, Nigeria and Tanzania is mainly explained by the decrease in economic resources.

Regarding policy recommendations, the approach adopted in this paper can be used to identify possible interventions which reduce poverty either by increasing economic resources or by decreasing the threat of domestic violence (by increasing freedom) or both actions simultaneously. The following measures (see Roesch, 2012) may help to improve women's freedom sets within their households:

1. Pass domestic violence legislation and provide resources to ensure it is implemented in the countries where it does not exist.
2. Implement and enforce the domestic violence legislation in the countries where it exists already.
3. Include modules on violence against women in education curriculum and in training for social workers, police, doctors, and teachers, since the population in those countries do not see domestic violence as a crime.

Appendix 3.A: Proof of Proposition 1

Sufficiency condition

First, we integrate by part

$$P = \sum_{k=1}^{K} \theta_k \int_{\underline{x}}^{\overline{x}} p(x, L_k)\, dF(x|L_k)$$

$$P = \sum_{k=1}^{K} \theta_k \left\{ p(x, L_k) D^1(x|L_k) \Big|_{\underline{x}}^{\overline{x}} - \int_{\underline{x}}^{\overline{x}} p^{(1)}(x, L_k) D^1(x|L_k) dx \right\}$$

We know that $D^1(\underline{x}|L_k) = 0$, $D^1(\overline{x}|L_k) = 1$ and $p(\overline{x}, L_k) \neq 0$ if $L_k \neq L_K$

$P = \sum_{k=1}^{K} \theta_k p(\overline{x}, L_k) D^1(\overline{x}|L_k) - \sum_{k-1}^{K} \theta_k \int_{\underline{x}}^{\overline{x}} p^{(1)}(x, L_k) D^1(x|L_k) dx$ (1)

Integrating by part again,

$$P = \sum_{k=1}^{K} \theta_k p(\overline{x}, L_k) D^1(\overline{x}|L_k) - \sum_{k-1}^{K} \theta_k \left\{ p^{(1)}(x, L_k) D^2(x|L_k) \Big|_{\underline{x}}^{\overline{x}} - \int_{\underline{x}}^{\overline{x}} p^{(2)}(x, L_k) D^2(x|L_k) dx \right\}$$

We know that $D^2(\underline{x}|L_k) = 0$ and $p^{(1)}(\overline{x}, L_k) = 0$

$$P = \sum_{k=1}^{K} \theta_k p(\overline{x}, L_k) D^1(\overline{x}|L_k) + (-1)^2 \sum_{k=1}^{K} \theta_k \int_{\underline{x}}^{\overline{x}} p^{(2)}(x, L_k) D^2(x|L_k) dx$$

Assume that $s - 1 > 1$, we have

$P = \sum_{k=1}^{K} \theta_k p(\overline{x}, L_k) D^1(\overline{x}|L_k) + (-1)^{s-1} \sum_{k=1}^{K} \theta_k \int_{\underline{x}}^{\overline{x}} p^{(s-1)}(x, L_k) D^{s-1}(x|L_k) dx$ (2)

Integrating by part, we have

$$P = \sum_{k=1}^{K} \theta_k p(\overline{x}, L_k) D^1(\overline{x}|L_k)$$

$$+ (-1)^{s-1} \sum_{k=1}^{K} \theta_k \left\{ p^{(s-1)}(x, L_k) D^s(x|L_k) \Big|_{\underline{x}}^{\overline{x}} - \int_{\underline{x}}^{\overline{x}} p^{(s)}(x, L_k) D^s(x|L_k) dx \right\}$$

We know that $D^s(\underline{x}|L_k) = 0$ and $p^{(s-1)}(\overline{x}, L_k) = 0$

$$P = \sum_{k=1}^{K} \theta_k p(\overline{x}, L_k) D^1(\overline{x}|L_k) + (-1)^s \sum_{k=1}^{K} \theta_k \int_{\underline{x}}^{\overline{x}} p^{(s)}(x, L_k) D^s(x|L_k) dx \qquad (3)$$

Since (1) obeys (2), we know that (3) is true for any *s*.

$$\Delta P_{AB} = P_A - P_B$$

$$\Delta P_{AB} = \sum_{k=1}^{K} \theta_{Ak} p(\overline{x}, L_k) D_A^1(\overline{x}|L_k) + (-1)^s \sum_{k=1}^{K} \theta_{Ak} \int_{\underline{x}}^{\overline{x}} p^{(s)}(x, L_k) D_A^s(x|L_k) dx$$

$$- \left[\sum_{k=1}^{K} \theta_{Bk} p(\overline{x}, L_k) D_B^1(\overline{x}|L_k) + (-1)^s \sum_{k=1}^{K} \theta_{Bk} \int_{\underline{x}}^{\overline{x}} p^{(s)}(x, L_k) D_B^s(x|L_k) dx \right]$$

$$\Delta P_{AB} = \sum_{k=1}^{K} [\theta_{Ak} D_A^1(\overline{x}|L_k) - \theta_{Bk} D_B^1(\overline{x}|L_k)] p(\overline{x}, L_k)$$

$$+ (-1)^s \int_{\underline{x}}^{\overline{x}} \sum_{k=1}^{K} [\theta_{Ak} D_A^s(x|L_k) - \theta_{Bk} D_B^s(x|L_k)] \, p^{(s)}(x, L_k) \, dx$$

Applying Abel's decomposition rule, we have

$$\Delta P_{AB} = \sum_{k=1}^{K-1} \left(\sum_{j=1}^{k} \left[\theta_{Aj} D_A^1(\overline{x}|L_j) - \theta_{Bj} D_B^1(\overline{x}|L_j) \right] \right) \left(p(\overline{x}, L_k) - p(\overline{x}, L_{k+1}) \right)$$

$$+ \left(\sum_{k=1}^{K} [\theta_{Ak} D_A^1(\overline{x}|L_k) - \theta_{Bk} D_B^1(\overline{x}|L_k)] \right) p(\overline{x}, L_K)$$

$$+ (-1)^s \int_{\underline{x}}^{\overline{x}} \left\{ \sum_{k=1}^{K-1} \left(\sum_{j=1}^{k} \left[\theta_{Aj} D_A^s(x|L_j) - \theta_{Bk} D_B^s(x|L_j) \right] \right) \left(p^{(s)}(x, L_k) - p^{(s)}(x, L_{k+1}) \right) \right.$$

$$\left. + \left(\sum_{k=1}^{K} [\theta_{Ak} D_A^s(x|L_k) - \theta_{Bk} D_B^s(x|L_k)] \right) p^{(s)}(x, L_K) \right\} dx$$

$p(\overline{x}, L_K) = 0$ since $\overline{x} \geq z_K^+$ and L_K is a set of freedom without restriction.

$$D_A^i(x, L_k) = \sum_{j=1}^{k} \theta_{Aj} D_A^i(x|L_j)$$

$$\Delta P_{AB} = \sum_{k=1}^{K-1} \left(D_A^1(\overline{x}, L_k) - D_B^1(\overline{x}, L_k)\right)\left(p(\overline{x}, L_k) - p(\overline{x}, L_{k+1})\right)$$

$$+ (-1)^s \int_{\underline{x}}^{\overline{x}} \left\{ \sum_{k=1}^{K-1} \left(D_A^s(x, L_k) - D_B^s(x, L_k)\right)\left(p^{(s)}(x, L_k) - p^{(s)}(x, L_{k+1})\right) \right.$$

$$\left. + \left(D_A^s(x, L_K) - D_B^s(x, L_K)\right)p^{(s)}(x, L_K) \right\} dx$$

$$\Delta P_{AB} = \sum_{k=1}^{K-1} \left(\Delta D_{AB}^1(\overline{x}, L_k)\right)\left(p(\overline{x}, L_k) - p(\overline{x}, L_{k+1})\right)$$

$$+ (-1)^s \int_{\underline{x}}^{\overline{x}} \left\{ \sum_{k=1}^{K-1} \left(\Delta D_{AB}^s(x, L_k)\right)\left(p^{(s)}(x, L_k) - p^{(s)}(x, L_{k+1})\right) \right.$$

$$\left. + \left(\Delta D_{AB}^s(x, L_K)\right)p^{(s)}(x, L_K) \right\} dx$$

$$\Delta P_{AB} = \sum_{k=1}^{K-1} \left(\Delta D_{AB}^1(\overline{x}, L_k)\right)\left(p(\overline{x}, L_k) - p(\overline{x}, L_{k+1})\right)$$

$$+ \int_{\underline{x}}^{\overline{x}} \left\{ \sum_{k=1}^{K-1} \left(\Delta D_{AB}^s(x, L_k)\right)\left((-1)^s p^{(s)}(x, L_k) - (-1)^s p^{(s)}(x, L_{k+1})\right) \right.$$

$$\left. + \left(\Delta D_{AB}^s(x, L_K)\right)(-1)^s p^{(s)}(x, L_K) \right\} dx$$

Based on the assumption, we know that:

$\left(p(\overline{x}, L_k) - p(\overline{x}, L_{k+1})\right) \geq 0$

$\left((-1)^s p^{(s)}(x, L_k) - (-1)^s p^{(s)}(x, L_{k+1})\right) \geq 0$

$(-1)^s p^{(s)}(x, L_K) \geq 0$

It is sufficient for $\Delta P_{AB} \geq 0$ if we have

$$\Delta D_{AB}^{s}(x, L_j) = D_A^s(x, L_j) - D_B^s(x, L_j) = \sum_{k=1}^{j} [\theta_{Ak} D_A^s(x|L_k) - \theta_{Bk} D_B^s(x|L_k)] \geq 0$$

$\forall x \in \mathcal{D} = [\underline{x}, \overline{x}], \forall j = 1,2, \dots, K.$

$$\Delta D_{AB}^{1}(\overline{x}, L_k) = D_A^1(\overline{x}, L_k) - D_B^1(\overline{x}, L_k) = \sum_{j=1}^{k} \left[\theta_{Aj} D_A^1(\overline{x}|L_j) - \theta_{Bj} D_B^1(\overline{x}|L_j)\right] \geq 0$$

$\forall k = 1,2, \dots, K-1$

Necessity condition

Suppose that $\Delta D_{AB}^{s}(x, L_j) = \sum_{k=1}^{j} [\theta_{Ak} D_A^s(x|L_k) - \theta_{Bk} D_B^s(x|L_k)] < 0 \ \forall \ k = 1,2, \dots, K$ in the range $x_1 \leq x \leq x_1 + \varepsilon$. Let choose the following set of function $p_0(x, L_k)$ with the $(s-1)$ derivative:

$$p_0(x, L_k) = \begin{cases} \delta & \forall \ k \leq i \\ 0 & \forall \ k > i \end{cases}$$

where $\delta > 0$.

$$p_0^{(1)}(x, L_k) = 0$$

$$p_0^{(2)}(x, L_k) = 0$$

$$\vdots$$

$$p_0^{(s)}(x, L_k) = 0$$

$$(-1)^j p_0^{(j)}(x, L_k) \geq 0 \ \forall \ j = 0,1,2, \dots s \Longrightarrow p_0(x, L_k) \in \Omega^s$$

Poverty indices whose function $p_0(x, L_k)$ have the above form belong to class Ω^s.

$$\Delta P_{AB} = \sum_{k=1}^{K} [\theta_{Ak} D_A(\overline{x}|L_k) - \theta_{Bk} D_B(\overline{x}|L_k)] p(\overline{x}, L_k)$$

$$+ (-1)^s \int_{\underline{x}}^{\overline{x}} \sum_{k=1}^{K} [\theta_{Ak} D_A^s(x|L_k) - \theta_{Bk} D_B^s(x|L_k)] \, p^{(s)}(x, L_k) \, dx$$

$$\Delta P_{AB} = \sum_{k=1}^{K} [\theta_{Ak} D_A(\overline{x}|L_k) - \theta_{Bk} D_B(\overline{x}|L_k)] p(\overline{x}, L_k)$$

$$+ \ (-1)^s \int_{x_1}^{x_1+\varepsilon} \sum_{k=1}^{K} [\theta_{Ak} D_A^s(x|L_k) - \theta_{Bk} D_B^s(x|L_k)] \, p^{(s)}(x, L_k) \, dx$$

$$\Delta P_{AB} = \sum_{k=1}^{i} [\theta_{Ak} D_A(\overline{x}|L_k) - \theta_{Bk} D_B(\overline{x}|L_k)] \delta + \ (-1)^s \int_{x_1}^{x_1+\varepsilon} \sum_{k=1}^{i} [\theta_{Ak} D_A^s(x|L_k) - \theta_{Bk} D_B^s(x|L_k)] \times 0 \, dx$$

$$\Delta P_{AB} = \delta \sum_{k=1}^{i} [\theta_{Ak} D_A(\overline{x}|L_k) - \theta_{Bk} D_B(\overline{x}|L_k)] < 0$$

Since $p_0(x, L_k) = \delta > 0 \ \forall \ k \leq i, \quad p_0^{(s)}(x, L_k) = 0 \ \forall \ k$ and $\Delta D_{AB}^s(x, L_j) = \sum_{k=1}^{j} [\theta_{Ak} D_A^s(x|L_k) - \theta_{Bk} D_B^s(x|L_k)] < 0$ in the range $x_1 \leq x \leq x_1 + \varepsilon$ and $\forall \ k = 1,2, \ldots K$.

$p_0(x, L_k) \in \Omega^s$ such that $\Delta P_{AB} < 0$.

It is given that $\Delta P_{AB} = P_A - P_B \geq 0 \ \forall \ p(x, L_k) \in \Omega^s$. The violation of $\Delta D_{AB}^s(x, L_j) = \sum_{k=1}^{j} [\theta_{Ak} D_A^s(x|L_k) - \theta_{Bk} D_B^s(x|L_k)] < 0$ in the range $x_1 \leq x \leq x_1 + \varepsilon$ is impossible.

Appendix 3.B: Tables

Table 3.1: Years and Observations by Country

Country	$Year_t$	Observations	$Year_{t+m}$	Observations
Burkina Faso	2003	12477	2010	17087
Ethiopia	2005	14070	2011	16515
Ghana	2003	5691	2008	4916
Kenya	2003	8195	2009	8444
Lesotho	2004	7095	2009	7624
Madagascar	2004	7949	2009	17375
Malawi	2004	11698	2010	23020
Nigeria	2003	7620	2008	33385
Rwanda	2005	11321	2010	13671
Senegal	2005	14602	2010	15688
Tanzania	2005	10329	2010	10139
Zimbabwe	2006	8907	2011	9171

Table 3.2: Country Summary Statistics

			Proportion of women in each freedom set (%)				Economic resources	
Country	Year	Observations	L1	L2	L3	L4	Mean	SD
Burkina Faso	2003	12005	64.65	8.68	2.52	24.16	1.962463	2.488624
	2010	16994	33.76	6.21	3.14	56.9	1.668814	1.773541
Ethiopia	2005	13852	59.02	14.32	2.37	24.3	1.19428	0.417088
	2011	16366	50.81	12.32	2.27	34.6	1.309492	0.602972
Ghana	2003	5634	37.17	11.77	3.14	47.92	1.826726	1.810777
	2008	4779	27.83	9.65	2.36	60.16	1.064094	0.459033
Kenya	2003	7965	52.33	13.48	2.55	31.64	1.588939	1.326208
	2009	8210	36.77	12.74	1.89	48.6	1.204436	0.579016
Lesotho	2004	6964	41.51	7.77	1.05	49.67	1.14879	0.890279
	2009	7494	32.68	5.63	1.35	60.34	1.030392	0.623936
Madagascar	2004	7803	6.96	20.45	1.24	71.34	0.880291	0.573435
	2009	16979	12.59	19.7	1.53	66.18	1.568601	1.305877
Malawi	2004	11406	19.13	8.15	2.45	70.27	2.710396	4.471799
	2010	22791	8.36	3.35	1.16	87.13	1.49996	1.356444
Nigeria	2003	7383	49.33	8.93	4.92	36.83	1.397675	1.018329
	2008	31929	37.08	7.12	2.9	52.91	1.203972	0.805303
Rwanda	2005	10849	17.6	28.62	2.88	50.91	3.278723	6.518292
	2010	13476	42.92	11.23	2.05	43.8	1.309328	0.832279
Senegal	2005	14331	60.76	5.44	2.35	31.45	1.168258	0.722469
	2010	15563	60.19	4.81	1.7	33.3	1.054673	0.547758
Tanzania	2005	10132	47.81	7.06	2.86	42.27	1.593235	1.414807
	2010	9874	39.27	6.44	2.95	51.34	1.526904	1.336403
Zimbabwe	2006	8774	35.16	8.95	4.92	50.97	1.179962	0.818808
	2011	8939	24.82	9.7	5.05	60.43	1.067417	0.65543

Table 3.3: Domestic Violence Legislation Year by Country

Country	Domestic Violence Legislation (DVL)Year
Burkina Faso	No DVL
Ethiopia	No DVL
Ghana	2007
Kenya	No DVL
Lesotho	No DVL
Madagascar	2000
Malawi	2006
Nigeria	No DVL*
Rwanda	2008
Senegal	1999
Tanzania	No DVL
Zimbabwe	2007

Notes: *State of Lagos passed Domestic Violence Legislation in 2013

Burkina Faso 2003 -2010

Table 3.4: Burkina Faso 2003

Dependent variable: dichotomous	
	(1)
Age	0.00113***
	(0.000185)
Region: Ouagadougou (Omitted)	
Boucle de mouhoun	0.0147***
	(0.00529)
Centre (sans Ouagadougou)	0.00106
	(0.0103)
Centre-sud	-0.0305**
	(0.0146)
Plateau central	-0.0849***
	(0.0235)
Centre-est	0.0143**
	(0.00576)
Centre-nord	0.00199
	(0.00825)
Centre-ouest	0.0185***
	(0.00424)
Est	-0.0128
	(0.0119)
Nord	-0.00998
	(0.0105)
Cascades	0.0224***
	(0.00294)
Hauts bassins	0.0156***
	(0.00520)
Sahel	0.0170***
	(0.00524)
Sud-ouest	0.0238***
	(0.00294)
Highest education level: no education (Omitted)	
Primary	3.83e-05
	(0.00542)
Secondary	0.00665
	(0.00671)
Higher	0.00104
	(0.0256)
Asset	6.02e-05
	(0.000976)
Observations	12,477
Pseudo R2	0.0933

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.5: Burkina Faso 2010

Dependent variable: dichotomous	
	(1)
Age	0.000300***
	(5.47e-05)
Asset	-0.000171
	(0.000255)
Observations	17,087
Pseudo R2	0.0316

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Ethiopia 2005-2011

Table 3.6: Ethiopia 2005

Dependent variable: dichotomous	
	(1)
Age	0.000755***
	(0.000119)
Region: Tigray (Omitted)	
Afar	-0.00521
	(0.00418)
Amhara	0.00949***
	(0.00158)
Oromiya	0.0126***
	(0.00199)
Somali	0.00672***
	(0.00129)
Benishangul-gumuz	0.00385**
	(0.00184)
Snnp	0.00870***
	(0.00156)
Gambela	0.00539***
	(0.00138)
Harari	0.00606***
	(0.00144)
Addis ababa	0.00535**
	(0.00225)
Dire dawa	0.00492***
	(0.00176)
Highest educational level: no education (Omitted)	
Primary	0.00156
	(0.00198)
Secondary	0.00260
	(0.00208)
Higher	0.00475
	(0.00310)
Asset	0.00343
	(0.00434)
Observations	14,070
Pseudo R2	0.0763

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.7: Ethiopia 2011

Dependent variable: dichotomous	
	(1)
Age	0.000353**
	(0.000157)
Region: Tigray (Omitted)	
Afar	0.000332
	(0.00508)
Amhara	-0.0173**
	(0.00798)
Oromiya	-0.0107*
	(0.00568)
Somali	-0.0267*
	(0.0138)
Benishangul-gumuz	-0.0147
	(0.00950)
Snnp	-0.00505
	(0.00564)
Gambela	-0.00378
	(0.00658)
Harari	0.000547
	(0.00475)
Addis ababa	0.00450
	(0.00317)
Dire dawa	-0.00669
	(0.00722)
Highest educational level: no education (Omitted)	
Primary	0.00387
	(0.00268)
Secondary	0.00198
	(0.00403)
Higher	0.00508
	(0.00359)
Asset	-0.00772**
	(0.00326)
Observations	16,515
Pseudo R2	0.0288

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Ghana 2003-2008

Table 3.8: Ghana 2003

Dependent variable: dichotomous	
	(1)
Age	0.000528***
	(0.000126)
Region: Western (Omitted)	
Central	0.00137
	(0.00381)
Greater accra	-0.00180
	(0.00431)
Volta	0.00139
	(0.00357)
Eastern	0.00238
	(0.00315)
Ashanti	0.00752***
	(0.00227)
Brong ahafo	0.00563***
	(0.00199)
Northern	0.000188
	(0.00389)
Upper west	0.00449**
	(0.00225)
Upper east	0.00456*
	(0.00240)
Asset	0.00147**
	(0.000692)
Observations	5,691
Pseudo R2	0.0662

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.9: Ghana 2008

Dependent variable: dichotomous	
	(1)
Age	0.000803***
	(0.000177)
Asset	0.0281***
	(0.00351)
Observations	4,916
Pseudo R2	0.1103

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Kenya 2003-2009

Table 3.10: Kenya 2003

Dependent variable: dichotomous	
	(1)
Age	0.00151***
	(0.000237)
Region: Nairobi (Omitted)	
Central	0.00142
	(0.00869)
Coast	-0.0291**
	(0.0145)
Eastern	-0.000996
	(0.00930)
Nyanza	-0.00631
	(0.0120)
Rift valley	-0.0150
	(0.0114)
Western	-0.00403
	(0.0106)
North eastern	-0.00195
	(0.0126)
Highest educational level: no education (Omitted)	
Primary	0.00740
	(0.00576)
Secondary	0.0147***
	(0.00475)
Higher	0.0105
	(0.00700)
Asset	-0.000398
	(0.00247)
Observations	8,195
Pseudo R2	0.0471

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.11: Kenya 2009

Dependent variable: dichotomous	
	(1)
Age	0.000803***
	(0.000180)
Region: Nairobi (Omitted)	
Central	0.0146***
	(0.00327)
Coast	-0.00441
	(0.00906)
Eastern	-0.000411
	(0.00711)
Nyanza	0.00750
	(0.00534)
Rift valley	0.00397
	(0.00616)
Western	0.00195
	(0.00669)
North eastern	-0.144***
	(0.0455)
Highest educational level: no education (Omitted)	
Primary	-0.00536
	(0.00515)
Secondary	-3.72e-05
	(0.00578)
Higher	-0.00773
	(0.0149)
Asset	0.00447
	(0.00393)
Observations	8,444
Pseudo R2	0.1031

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Lesotho 2004-2009

Table 3.12: Lesotho 2004

Dependent variable: dichotomous	
	(1)
Age	0.000543***
	(0.000163)
Region: Butha-buthe (Omitted)	
Leribe	-0.0252**
	(0.0124)
Berea	-0.00363
	(0.00830)
Maseru	-0.00319
	(0.00679)
Mafeteng	-0.00815
	(0.00931)
Mohale's hoek	-0.0132
	(0.00993)
Quthing	-0.0534***
	(0.0201)
Qasha's nek	-0.0115
	(0.0127)
Mokhotlong	-0.0378**
	(0.0173)
Thaba-tseka	-0.00243
	(0.00899)
Highest educational level: no education (Omitted)	
Primary	0.0102
	(0.0104)
Secondary	0.0126
	(0.00813)
Higher	0.00867
	(0.00625)
Asset	-0.000787
	(0.00161)
Observations	7,095
Pseudo R2	0.0508

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.13: Lesotho 2009

Dependent variable: dichotomous	
	(1)
Age	0.000435**
	(0.000187)
Region: Butha-buthe (Omitted)	
Leribe	0.00512
	(0.00548)
Berea	-0.00609
	(0.00822)
Maseru	-0.00503
	(0.00773)
Mafeteng	0.00215
	(0.00673)
Mohale's hoek	-0.00187
	(0.00855)
Quthing	-0.00119
	(0.00742)
Qasha's nek	-0.0320*
	(0.0164)
Mokhotlong	-0.00407
	(0.00822)
Thaba-tseka	-0.000974
	(0.00715)
Highest educational level: no education (Omitted)	
Primary	0.00888
	(0.0100)
Secondary	0.0148
	(0.0107)
Higher	0.00960
	(0.00602)
Asset	0.000178
	(0.00314)
Observations	7,624
Pseudo R2	0.0232

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Madagascar 2004-2009

Table 3.14: Madagascar 2004

Dependent variable: dichotomous	
	(1)
Age	0.000836***
	(0.000232)
Region: Antananarivo (Omitted)	
Fianarantsoa	-0.0139*
	(0.00719)
Toamasina	-0.0129
	(0.00786)
Mahajanga	0.00652
	(0.00568)
Toliary	0.00482
	(0.00551)
Antsiranana	-0.0152
	(0.01000)
Highest educational level: no education (Omitted)	
primary	0.00829
	(0.00515)
Secondary	0.00915**
	(0.00435)
Higher	-0.00437
	(0.0169)
Asset	0.00468
	(0.00387)
Observations	7,949
Pseudo R2	0.0469

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.15: Madagascar 2009

Dependent variable: dichotomous	
	(1)
Age	0.000570***
	(0.000106)
Region: Analamanga (Omitted)	
Vakinankaratra	0.00726*
	(0.00429)
Itasy	0.00812**
	(0.00393)
Bongolava	-0.0369***
	(0.0129)
Haute matsiatra	-0.0297***
	(0.0110)
Anamoroni'i mania	-0.0420***
	(0.0134)
Vatovavy fitovinany	-0.0784***
	(0.0204)
Ihorombe	0.00739**
	(0.00369)
Atsimo atsinanana	-0.0416***
	(0.0145)
Atsinanana	0.00274
	(0.00498)
Analanjirofo	-0.000320
	(0.00666)
Alaotra mangoro	-0.00210
	(0.00674)
Boeny	0.00768*
	(0.00435)
Sofia	0.00359
	(0.00480)
Betsiboka	-0.00327
	(0.00680)
Melaky	-0.0230*
	(0.0118)
Atsimo andrefana	-0.0108
	(0.00889)
Androy	-0.00582
	(0.00776)
Anosy	-0.0114
	(0.00870)
Menabe	0.00406
	(0.00534)
Diana	-0.0130
	(0.00865)
Sava	-0.0231**
	(0.0114)
Highest educational level: no education (Omitted)	
primary	0.00703***
	(0.00232)
Secondary	0.00761***
	(0.00260)
Higher	-0.00479
	(0.0113)
Asset	0.00212*
	(0.00115)
Observations	17,375
Pseudo R2	0.1053

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Malawi 2004-2010

Table 3.16: Malawi 2004

Dependent variable: dichotomous	
	(1)
Age	0.00206***
	(0.000161)
Region: Northern (Omitted)	
Central	-0.00453
	(0.00284)
Southern	0.00654**
	(0.00278)
Asset	-4.01e-05
	(0.000194)
Observations	11,698
Pseudo R2	0.1394

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.17: Malawi 2010

Dependent variable: dichotomous	
	(1)
Age	0.000562***
	(7.83e-05)
Region: Northern (Omitted)	
Central	0.00524***
	(0.00140)
Southern	0.00267*
	(0.00138)
Highest educational level: no education (Omitted)	
Primary	0.00327
	(0.00225)
Secondary	0.00570***
	(0.00141)
Higher	0.00677***
	(0.000941)
Asset	0.000554
	(0.000437)
Observations	23,020
Pseudo R2	0.0463

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Nigeria 2003-2008

Table 3.18: Nigeria 2003

Dependent variable: dichotomous	
	(1)
Age	0.00164***
	(0.000213)
Region: North central (Omitted)	
North east	-0.00500
	(0.00623)
North west	-0.00819
	(0.00619)
South east	-0.0196*
	(0.0102)
South south	-0.00558
	(0.00804)
South west	-0.0136*
	(0.00821)
Highest educational level: no education (Omitted)	
Primary	-0.0204**
	(0.00860)
Secondary	-0.0181**
	(0.00724)
Higher	-0.0215
	(0.0140)
Asset	0.00448**
	(0.00179)
Observations	7,620
Pseudo R2	0.0965

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.19: Nigeria 2008

Dependent variable: dichotomous	
	(1)
Age	0.00218***
	(0.000145)
Region: North central (Omitted)	
North east	0.0108***
	(0.00312)
North west	-0.00510
	(0.00363)
South east	0.00485
	(0.00395)
South west	-0.0144***
	(0.00456)
South south	0.0123***
	(0.00339)
Highest educational level: no education (Omitted)	
Primary	-0.00804**
	(0.00375)
Secondary	-0.0116***
	(0.00395)
Higher	0.00320
	(0.00567)
Asset	0.00211
	(0.00185)
Observations	33,385
Pseudo R2	0.0435

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Rwanda 2005-2010

Table 3.20: Rwanda 2005

Dependent variable: dichotomous	
	(1)
Age	0.00212***
	(0.000201)
Region: City of Kigali (Omitted)	
Kigali ngali	0.0263***
	(0.00388)
Gitarama	0.00380
	(0.00756)
Butare	0.0250***
	(0.00398)
Gikongoro	0.0121**
	(0.00595)
Cyangugu	0.0186***
	(0.00478)
Kibuye	-0.0151
	(0.0106)
Gisenyi	-0.0116
	(0.00952)
Ruhengeri	-0.00971
	(0.00956)
byumba	0.0184***
	(0.00503)
Umutara	-0.0172
	(0.0112)
Kibungo	0.0202***
	(0.00498)
Highest educational level: no education (Omitted)	
Primary	0.00304
	(0.00424)
Secondary	0.0100*
	(0.00565)
Higher	0.0247***
	(0.00537)
Asset	0.000515
	(0.000337)
Observations	11,321
Pseudo R2	0.0851

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.21: Rwanda 2010

Dependent variable: dichotomous	
	(1)
Age	0.000610***
	(0.000117)
Region: Kigali city (omitted)	
South	-0.00283
	(0.00438)
West	-0.0111**
	(0.00547)
North	-0.00138
	(0.00480)
East	-0.00184
	(0.00421)
Highest educational level: no education (Omitted)	
Primary	-0.000708
	(0.00278)
Secondary	0.00346
	(0.00324)
Higher	0.000946
	(0.00829)
Asset	0.000172
	(0.00158)
Observations	13,671
Pseudo R2	0.0267

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Senegal 2005-2010

Table 3.22: Senegal 2005

Dependent variable: dichotomous	
	(1)
Age	0.00108***
	(0.000153)
Region: Dakar (Omitted)	
Diourbel	0.0133***
	(0.00225)
Fatick	0.0100***
	(0.00270)
Kaolack	0.0108***
	(0.00261)
Kolda	0.0154***
	(0.00189)
Louga	0.00442
	(0.00347)
Matam	0.00485
	(0.00341)
Saint-louis	0.00705**
	(0.00295)
Tambacounda	0.0120***
	(0.00233)
Thiès	0.0130***
	(0.00236)
Zuguinchor	0.0125***
	(0.00207)
Highest educational level: no education (Omitted)	
Primary	-0.000669
	(0.00306)
Secondary	0.00610**
	(0.00311)
Higher	0.00484
	(0.0107)
Asset	0.00382*
	(0.00215)
Observations	14,602
Pseudo R2	0.0637

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.23: Senegal 2010

Dependent variable: dichotomous	
	(1)
Age	0.000304**
	(0.000120)
Region: Dakar (Omitted)	
Ziguinchor	0.00361
	(0.00233)
Diourbel	0.00405*
	(0.00235)
Saint-louis	-0.00303
	(0.00395)
Tambacounda	0.00275
	(0.00254)
Kaolack	0.00265
	(0.00243)
Thiès	0.00589***
	(0.00202)
Louga	0.00184
	(0.00265)
Fatick	0.00399*
	(0.00209)
Kolda	0.00431**
	(0.00208)
Matam	0.00158
	(0.00296)
Kaffrine	0.00469**
	(0.00191)
Kedougou	0.00490**
	(0.00208)
Sedhiou	0.00685***
	(0.00126)
Highest educational level: no education (Omitted)	
Primary	-0.00101
	(0.00231)
Secondary	-5.21e-05
	(0.00263)
Higher	0.00562***
	(0.00205)
Asset	0.00211
	(0.00172)
Observations	15,688
Pseudo R2	0.0337

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Tanzania 2005-2010

Table 3.24: Tanzania 2005

Dependent variable: dichotomous	
	(1)
Age	0.00102***
	(0.000125)
Region: Dodoma (Omitted)	
Arusha	0.00321
	(0.00474)
Kilimanjaro	-0.00619
	(0.00964)
Tanga	-0.00273
	(0.00772)
Morogoro	0.00720**
	(0.00286)
Pwani	0.00455
	(0.00421)
Dar es salam	0.00232
	(0.00541)
Lindi	-0.00553
	(0.00890)
Mtwara	-0.00531
	(0.00963)
Ruvuma	0.00709**
	(0.00276)
Iringa	0.00325
	(0.00535)
Mbeya	-0.00430
	(0.00811)
Singida	-0.00658
	(0.00909)
Tabora	0.00870***
	(0.00201)
Rukwa	-0.00247
	(0.00697)
Kigoma	0.00631*
	(0.00356)
Shinyanga	-0.0250*
	(0.0148)
Kagera	-0.00571
	(0.00881)
Mwanza	-0.0105
	(0.00995)
Mara	-0.00505
	(0.00822)
Manyara	0.00522
	(0.00371)
Zanzibar north	-0.00424
	(0.00857)
Zanziba south	0.00328
	(0.00458)
Town west	-0.0106
	(0.0113)
Pemba north	-0.0500**
	(0.0250)
Pemba south	-0.0263
	(0.0169)
Highest educational level: no education (Omitted)	
Primary	0.00749***
	(0.00290)
Secondary	0.00618***
	(0.00199)
Higher	0.00862***
	(0.00165)
Asset	-0.000833
	(0.000838)
Observations	10,329
Pseudo R2	0.1271

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.25: Tanzania 2010

Dependent variable: dichotomous	
	(1)
Age	0.00152***
	(0.000166)
Asset	-0.000265
	(0.00101)
Observations	10,139
Pseudo R2	0.0607

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Zimbabwe 2006-2011

Table 3.26: Zimbabwe 2006

Dependent variable: dichotomous	
	(1)
Age	0.000660***
	(0.000189)
Region: Manicaland (Omitted)	
Mashonaland central	0.00982***
	(0.00210)
Mashonaland east	-0.000208
	(0.00430)
Mashonaland west	0.00351
	(0.00331)
Matebeleland north	0.00715***
	(0.00233)
Matebeleland south	-0.0154**
	(0.00781)
Midlands	0.0126***
	(0.00224)
Masvingo	-0.000924
	(0.00622)
Harare	0.000394
	(0.00387)
Bulawayo	0.00265
	(0.00361)
Highest educational level: no education (Omitted)	
Primary	0.0139**
	(0.00646)
Secondary	0.0325*
	(0.0177)
Higher	0.00996***
	(0.00178)
Asset	-0.00304
	(0.00202)
Observations	8,907
Pseudo R2	0.0783

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Table 3.27: Zimbabwe 2011

Dependent variable: dichotomous	
	(1)
Age	0.00119***
	(0.000197)
Region: Manicaland (Omitted)	
Mashonaland central	0.00867*
	(0.00470)
Mashonaland east	0.00852*
	(0.00487)
Mashonaland west	-0.00590
	(0.00737)
Matebeleland north	-0.0441***
	(0.0149)
Matebeleland south	0.00842*
	(0.00496)
Midlands	-0.0119
	(0.00820)
Masvingo	0.00303
	(0.00625)
Harare	-0.0181**
	(0.00906)
Bulawayo	-0.0114
	(0.00956)
Highest educational level: no education (Omitted)	
Primary	0.0231***
	(0.00514)
Secondary	0.0318***
	(0.0121)
Higher	0.0190***
	(0.00222)
Asset	-0.00261
	(0.00265)
Observations	9,171
Pseudo R2	0.0641

Notes: Robust standard errors
*** p<0.01, ** p<0.05, * p<0.1

Standard approach

Table 3.28a: Critical Thresholds under which 2010 Dominates 2003 in Burkina Faso

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	0.92928669 pn	3.6401483 pn	6.784189 pn

Table 3.29a: Critical Thresholds under which 2011 Dominates 2005 in Ethiopia

	s=1	s=2	s=3
z_1^s	0.94328466 np	1.0416525 np	1.1540728 np
z_2^s	0.98544228 np	1.1259678 np	1.3332429 np

Table 3.30a: Critical Thresholds under which 2008 Dominates 2003 in Ghana

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	0.99006438 pn	1.5634556 pn	2.1827181 pn

Table 3.31a: Critical Thresholds under which 2009 Dominates 2003 in Kenya

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	1.1742282 pn	2.301696 pn	3.5831597 pn

Table 3.32a: Critical Thresholds under which 2009 Dominates 2004 in Lesotho

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	1.3474605 pn	2.3972432 pn	4.4059181 pn

Table 3.33a: Critical Thresholds under which 2009 Dominates 2004 in Madagascar

	s=1	s=2	s=3
z_1^s	3.1779626 pn	p	p
z_2^s	5.6635435 pn	p	p

Table 3.34a: Critical Thresholds under which 2010 Dominates 2004 in Malawi

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	1.231892 pn	2.5072374 pn	3.9275084 pn

Table 3.35a: Critical Thresholds under which 2008 Dominates 2003 in Nigeria

	s=1	s=2	s=3
z_1^s	0.47724619 np	0.62652078 np	0.7667484 np
z_2^s	0.64913812 np	1.0517271 np	1.6850131 np

Table 3.36a: Critical Thresholds under which 2010 Dominates 2005 in Rwanda

	s=1	s=2	s=3
z_1^s	0.92534569 pn	1.6756141 pn	2.675972 pn
z_2^s	1.0253815 pn	2.8260255 pn	4.7767232 pn

Table 3.37a: Critical Thresholds under which 2010 Dominates 2005 in Senegal

	s=1	s=2	s=3
z_1^s	1.4055773 pn	1.9024773 pn	3.0039968 pn
z_2^s	1.4194767 pn	1.9024773 pn	2.7399102 pn

Table 3.38a: Critical Thresholds under which 2010 Dominates 2005 in Tanzania

	s=1	s=2	s=3
z_1^s	0.52342308 np	1.1135636 np	1.6966785 np
z_2^s	0.99413031 np	n	n

Table 3.39a: Critical Thresholds under which 2011 Dominates 2006 in Zimbabwe

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	0.85331351 pn	1.5865175 pn	2.1132443 pn

Extended approach

Table 3.28b: Critical Thresholds under which 2010 Dominates 2003 in Burkina Faso

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	0.9432602 pn	3.7938569 pn	7.0217385 pn

Table 3.29b: Critical Thresholds under which 2011 Dominates 2005 in Ethiopia

	s=1	s=2	s=3
z_1^s	0.94328466 np	1.0486788 np	1.1681254 np
z_2^s	0.94328466 np	1.0416525 np	1.1540728 np
z_3^s	0.94679779 np	1.0451656 np	1.157586 np
z_4^s	0.98895541 np	1.1329941 np	1.3472955 np

Table 3.30b: Critical Thresholds under which 2008 Dominates 2003 in Ghana

	s=1	s=2	s=3
z_1^s	1.3952608 pn	p	p
z_2^s	1.3417443 pn	p	p
z_3^s	1.3264539 pn	p	p
z_4^s	0.99006438 pn	1.5634556 pn	2.1903633 pn

Table 3.31b: Critical Thresholds under which 2009 Dominates 2003 in Kenya

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	1.1742282 pn	2.3071959 pn	3.5886595 pn

Table 3.32b: Critical Thresholds under which 2009 Dominates 2004 in Lesotho

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	1.3474605 pn	2.4017877 pn	4.4150073 pn

Table 3.33b: Critical Thresholds under which 2009 Dominates 2004 in Madagascar

	s=1	s=2	s=3
z_1^s	0.85461081 pn	1.7990156 pn	2.8129471 pn
z_2^s	3.1837565 pn	p	p
z_3^s	3.1779626 pn	p	p
z_4^s	5.6635435 pn	p	p

Table 3.34b: Critical Thresholds under which 2010 Dominates 2004 in Malawi

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	1.231892 pn	2.5072374 pn	3.9275084 pn

Table 3.35b: Critical Thresholds under which 2008 Dominates 2003 in Nigeria

	s=1	s=2	s=3
z_1^s	0.47724619 np	0.6219973 np	0.75770143 np
z_2^s	0.50438702 np	0.63556769 np	0.7803188 np
z_3^s	0.47724619 np	0.62652078 np	0.7667484 np
z_4^s	0.64913812 np	1.0472036 np	1.6714428 np

Table 3.36b: Critical Thresholds under which 2010 Dominates 2005 in Rwanda

	s=1	s=2	s=3
z_1^s	0.77529201pn	1.0253815 pn	1.3254888 pn
z_2^s	0.92534569 pn	1.5755783 pn	2.5759361 pn
z_3^s	0.92534569 pn	1.6756141 pn	2.675972 pn
z_4^s	1.0253815 pn	2.8260255 pn	4.7767232 pn

Table 3.37b: Critical Thresholds under which 2010 Dominates 2005 in Senegal

	s=1	s=2	s=3
z_1^s	1.2770088 pn	1.7252613 pn	2.4167514 pn
z_2^s	1.353455 pn	1.8086571 pn	2.6495646 pn
z_3^s	1.4090522 pn	1.9163766 pn	3.0700184 pn
z_4^s	1.4229515 pn	1.909427 pn	2.7572841 pn

Table 3.38b: Critical Thresholds under which 2010 Dominates 2005 in Tanzania

	s=1	s=2	s=3
z_1^s	0.50234663 np	1.0152069 np	1.5350924 np
z_2^s	0.52342308 np	1.0784361 np	1.6334492 np
z_3^s	0.52342308 np	1.106538 np	1.6896531 np
z_4^s	0.99413031 np	n	n

Table 3.39b: Critical Thresholds under which 2011 Dominates 2006 in Zimbabwe

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	0.85331351 pn	1.5780898 pn	2.1048167 pn

Standard Approach

Table 3.40a: Critical Thresholds under which 2010 Dominates 2003, Explained by the Change in the Incidence of the Threat of Domestic Violence in Burkina Faso

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p

Table 3.41a: Critical Thresholds under which 2011 Dominates 2005, Explained by the Change in the Incidence of the Threat of Domestic Violence in Ethiopia

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p

Table 3.42a: Critical Thresholds under which 2008 Dominates 2003, Explained by the Change in the Incidence of the Threat of Domestic Violence in Ghana

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p

Table 3.43a: Critical Thresholds under which 2009 Dominates 2003, Explained by the Change in the Incidence of the Threat of Domestic Violence in Kenya

	s=1	s=2	s=3
z_1^s	P	p	p
z_2^s	P	p	p

Table 3.44a: Critical Thresholds under which 2009 Dominates 2004, Explained by the Change in the Incidence of the Threat of Domestic Violence in Lesotho

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p

Table 3.45a: Critical Thresholds under which 2009 Dominates 2004, Explained by the Change in the Incidence of the Threat of Domestic Violence in Madagascar

	s=1	s=2	s=3
z_1^s	n	n	n
z_2^s	n	n	n

Table 3.46a: Critical Thresholds under which 2010 Dominates 2004, Explained by the Change in the Incidence of the Threat of Domestic Violence in Malawi

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p

Table 3.47a: Critical Thresholds under which 2008 Dominates 2003, Explained by the Change in the Incidence of the Threat of Domestic Violence in Nigeria

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p

Table 3.48a: Critical Thresholds under which 2010 Dominates 2005, Explained by the Change in the Incidence of the Threat of Domestic Violence in Rwanda

	s=1	s=2	s=3
z_1^s	n	n	n
z_2^s	n	n	n

Table 3.49a: Critical Thresholds under which 2010 Dominates 2005, Explained by the Change in the Incidence of the Threat of Domestic Violence in Senegal

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p

Table 3.50a: Critical Thresholds under which 2010 Dominates 2005, Explained by the Change in the Incidence of the Threat of Domestic Violence in Tanzania

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p

Table 3.51a: Critical Thresholds under which 2011 Dominates 2006, Explained by the Change in the Incidence of the Threat of Domestic Violence in Zimbabwe

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p

Extended Approach

Table 3.40b: Critical thresholds under which 2010 Dominates 2003, Explained by the Change in the Incidence of the Threat of Domestic Violence in Burkina Faso

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	p	p	p

Table 3.41b: Critical Thresholds under which 2011 Dominates 2005, Explained by the Change in the Incidence of the Threat of Domestic Violence in Ethiopia

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	p	p	p

Table 3.42b: Critical thresholds under which 2008 Dominates 2003, Explained by the Change in the Incidence of the Threat of Domestic Violence in Ghana

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	p	p	p

Table 3.43b: Critical thresholds under which 2009 Dominates 2003, Explained by the Change in the Incidence of the Threat of Domestic Violence in Kenya

	s=1	s=2	s=3
z_1^s	P	p	p
z_2^s	P	p	p
z_3^s	P	p	p
z_4^s	P	p	p

Table 3.44b: Critical Thresholds under which 2009 Dominates 2004, Explained by the Change in the Incidence of the Threat of Domestic Violence in Lesotho

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	p	p	p

Table 3.45b: Critical Thresholds under which 2009 Dominates 2004, Explained by the Change in the Incidence of the Threat of Domestic Violence in Madagascar

	s=1	s=2	s=3
z_1^s	n	n	n
z_2^s	n	n	n
z_3^s	n	n	n
z_4^s	n	n	n

Table 3.46b: Critical Thresholds under which 2010 Dominates 2004, Explained by the Change in the Incidence of the Threat of Domestic Violence in Malawi

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	p	p	p

Table 3.47b: Critical Thresholds under which 2008 Dominates 2003, Explained by the Change in the Incidence of the Threat of Domestic Violence in Nigeria

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	p	p	p

Table 3.48b: Critical Thresholds under which 2010 Dominates 2005, Explained by the Change in the Incidence of the Threat of Domestic Violence in Rwanda

	s=1	s=2	s=3
z_1^s	n	n	n
z_2^s	n	n	n
z_3^s	n	n	n
z_4^s	n	n	n

Table 3.49b: Critical Thresholds under which 2010 Dominates 2005, explained by the change in the incidence of the Threat of Domestic Violence in Senegal

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	p	p	p

Table 3.50b: Critical Thresholds under which 2010 Dominates 2005, Explained by the Change in the Incidence of the Threat of Domestic Violence in Tanzania

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	p	p	p

Table 3.51b: Critical Thresholds under which 2011 Dominates 2006, Explained by the Change in the Incidence of the Threat of Domestic Violence in Zimbabwe

	s=1	s=2	s=3
z_1^s	p	p	p
z_2^s	p	p	p
z_3^s	p	p	p
z_4^s	p	p	p

Standard Approach

Table 3.52a: Critical Thresholds under which 2010 Dominates 2003, Explained by the Change in the Economic Resources in Burkina Faso

	s=1	s=2	s=3
z_1^s	0.83147207 pn	2.1869029 pn	4.0034596 pn
z_2^s	0.8594191 pn	2.354585 pn	4.1711418 pn

Table 3.53a: Critical Thresholds under which 2011 Dominates 2005, Explained by the Change in the Economic Resources in Ethiopia

	s=1	s=2	s=3
z_1^s	1.0030081 np	1.2770327 np	1.6599646 np
z_2^s	0.99949487 np	1.2454144 np	1.5826756 np

Table 3.54a: Critical Thresholds under which 2008 Dominates 2003, Explained by the Change in the Economic Resources in Ghana

	s=1	s=2	s=3
z_1^s	0.93654788 pn	1.5481652pn	2.2591702 pn
z_2^s	0.94419309 pn	1.471713 pn	2.0374589 pn

Table 3.55a: Critical Thresholds under which 2009 Dominates 2003, Explained by the Change in the Economic Resources in Kenya

	s=1	s=2	s=3
z_1^s	0.94873458 pn	2.0982019 pn	3.4456635 pn
z_2^s	0.9652341 pn	1.988205 pn	2.939678 pn

Table 3.56a: Critical Thresholds under which 2009 Dominates 2004, Explained by the Change in the Economic Resources in Lesotho

	s=1	s=2	s=3
z_1^s	1.1520464 pn	2.1018497 pn	3.9060217 pn
z_2^s	1.2929263 pn	2.0473155 pn	3.2425225 pn

Table 3.57a: Critical Thresholds under which 2009 Dominates 2004, Explained by the Change in the Economic Resources in Madagascar

	s=1	s=2	s=3
z_1^s	5.6113984	p	p
z_2^s	p	p	p

Table 3.58a: Critical Thresholds under which 2010 Dominates 2004, Explained by the Change in the Economic Resources in Malawi

	s=1	s=2	s=3
z_1^s	1.3188474 pn	2.8260737 pn	4.4492407 pn
z_2^s	1.2029069 pn	2.2753564 pn	3.5217167 pn

Table 3.59a: Critical Thresholds under which 2008 Dominates 2003, Explained by the Change in the Economic Resources in Nigeria

	s=1	s=2	s=3
z_1^s	0.74413103 np	n	n
z_2^s	0.76222491 np	n	n

Table 3.60a: Critical Thresholds under which 2010 Dominates 2005, Explained by the Change in the Economic Resources in Rwanda

	s=1	s=2	s=3
z_1^s	0.97536357 pn	2.3758645 pn	4.2765443 pn
z_2^s	1.0253815 pn	2.9760792 pn	4.976795 pn

Table 3.61a: Critical Thresholds under which 2010 Dominates 2005, Explained by the Change in the Economic Resources in Senegal

	s=1	s=2	s=3
z_1^s	1.2978578 pn	1.7391606 pn	2.4202262 pn
z_2^s	1.4090522 pn	1.8712039 pn	2.6495646 pn

Table 3.62a: Critical Thresholds under which 2010 Dominates 2005, Explained by the Change in the Economic Resources in Tanzania

	s=1	s=2	s=3
z_1^s	n	n	n
z_2^s	n	n	n

Table 3.63a: Critical Thresholds under which 2011 Dominates 2006, Explained by the Change in the Economic Resources in Zimbabwe

	s=1	s=2	s=3
z_1^s	0.88702404 pn	1.847774 pn	3.0276423 pn
z_2^s	0.78167862 pn	1.3210471 pn	1.805636 pn

Extended Approach

Table 3.52b: Critical Thresholds under which 2010 Dominates 2003, Explained by the Change in the Economic Resources in Burkina Faso

	s=1	s=2	s=3
z_1^s	0.76160451 pn	2.2567705 pn	4.2270358 pn
z_2^s	0.84544561 pn	2.2288235 pn	4.1152477 pn
z_3^s	0.83147207 pn	2.158956 pn	3.9615392 pn
z_4^s	0.8594191 pn	2.3406116 pn	4.1431949 pn

Table 3.53b: Critical Thresholds under which 2011 Dominates 2005, Explained by the Change in the Economic Resources in Ethiopia

	s=1	s=2	s=3
z_1^s	1.0065212 np	1.3297297 np	1.8110296 np
z_2^s	1.0030081 np	1.3086509np	1.7267142 np
z_3^s	1.0065212 np	1.3121641 np	1.7337405 np
z_4^s	0.99949487 np	1.2700064 np	1.6248333 np

Table 3.54b: Critical Thresholds under which 2008 Dominates 2003, Explained by the Change in the Economic Resources in Ghana

	s=1	s=2	s=3
z_1^s	0.92890265 pn	1.5711008 pn	2.3203319 pn
z_2^s	0.93654788 pn	1.5634556 pn	2.2744606 pn
z_3^s	0.93654788 pn	1.5481652 pn	2.2515249 pn
z_4^s	0.94419309 pn	1.471713 pn	2.0374589 pn

Table 3.55b: Critical Thresholds under which 2009 Dominates 2003, Explained by the Change in the Economic Resources in Kenya

	s=1	s=2	s=3
z_1^s	0.93223506 pn	2.1422007 pn	3.7041562 pn
z_2^s	0.92673522 pn	2.0927019 pn	3.4456635 pn
z_3^s	0.92673522 pn	2.054203 pn	3.324667 pn
z_4^s	0.95423442 pn	1.9662056 pn	2.8956793 pn

Table 3.56b: Critical Thresholds under which 2009 Dominates 2004, Explained by the Change in the Economic Resources in Lesotho

	s=1	s=2	s=3
z_1^s	1.1475019 pn	2.1700174 pn	p
z_2^s	1.1475019 pn	2.0745827 pn	3.7924089 pn
z_3^s	1.1475019 pn	2.0745827 pn	3.7924089 pn
z_4^s	1.1611354 pn	2.1427504 pn	4.0878021 pn

Table 3.57b: Critical Thresholds under which 2009 Dominates 2004, Explained by the Change in the Economic Resources in Madagascar

	s=1	s=2	s=3
z_1^s	5.6056044	p	p
z_2^s	5.6113984	p	p
z_3^s	5.6113984	p	p
z_4^s	p	p	p

Table 3.58b: Critical Thresholds under which 2010 Dominates 2004, Explained by the Change in the Economic Resources in Malawi

	s=1	s=2	s=3
z_1^s	1.231892 pn	2.5652077 pn	4.1304042 pn
z_2^s	1.3188474 pn	2.9130292 pn	4.5941663 pn
z_3^s	1.3188474 pn	2.8260737 pn	4.4782257 pn
z_4^s	1.2029069 pn	2.2753564 pn	3.5217167 pn

Table 3.59b: Critical Thresholds under which 2008 Dominates 2003, Explained by the Change in the Economic Resources in Nigeria

	s=1	s=2	s=3
z_1^s	0.74413103 np	n	n
z_2^s	0.72603715 np	n	n
z_3^s	0.74413103 np	n	n
z_4^s	0.76222491 np	n	n

Table 3.60b: Critical Thresholds under which 2010 Dominates 2005, Explained by the Change in the Economic Resources in Rwanda

	s=1	s=2	s=3
z_1^s	0.97536357 pn	2.4258825 pn	4.3265622 pn
z_2^s	1.0253815 pn	2.5259183 pn	4.4766161 pn
z_3^s	1.0253815 pn	2.5259183 pn	4.4766161 pn
z_4^s	1.0253815 pn	3.0260971 pn	5.0768306 pn

Table 3.61b: Critical Thresholds under which 2010 Dominates 2005, Explained by the Change in the Economic Resources in Senegal

	s=1	s=2	s=3
z_1^s	1.197088 pn	1.6731389 pn	2.2916576 pn
z_2^s	1.2804837 pn	1.7217865 pn	2.3889528 pn
z_3^s	1.3326061 pn	1.7669591 pn	2.4931976 pn
z_4^s	1.4160019 pn	1.888578 pn	2.701687 pn

Table 3.62b: Critical Thresholds under which 2010 Dominates 2005, Explained by the Change in the Economic Resources in Tanzania

	s=1	s=2	s=3
z_1^s	n	n	n
z_2^s	n	n	n
z_3^s	n	n	n
z_4^s	n	n	n

Table 3.63b: Critical Thresholds under which 2011 Dominates 2006, Explained by the Change in the Economic Resources in Zimbabwe

	s=1	s=2	s=3
z_1^s	0.86174113 pn	1.801422 pn	2.8169515 pn
z_2^s	0.85331351 pn	1.7466423 pn	2.602047 pn
z_3^s	0.84488589 pn	1.7002904 pn	2.4419219 pn
z_4^s	0.75639576 pn	1.2030602 pn	1.6918628 pn

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