Special Article

Poverty Reduction:

Fuzzy Sets vs. Crisp Sets Compared

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Abstract

This paper examines the results of economic poverty reduction modelling in selected countries 1992-2002 using the fuzzy set method (fsQCA) and the crisp set method (csQCA). The fsQCA and csQCA are the two main configurational comparative methods (CCM). This paper primarily focuses on making sensitivity assessments of the fsQCA and csQCA results. The outcomes of CCM based on the truth table algorithm are determined by the calibration of the set-relation membership score as well as the outcome variable of the interim truth table (called the consistency cutoff). Calibration of the raw data into crisp- and fuzzy-set membership scores based on theoretically and empirically grounded establishment of thresholds has been emphasised as it shapes the truth table algorithm. Thus, like previous studies of sensitivity assessment we focus on calibration. However this paper shows how to determine the balance of consistency and coverage outcomes based on various cutoff points as being highly important for a sensitivity assessment. We argue that the optimal consistency cutoff point helps us optimally determine the configurational multiple causality. The outcomes of fsQCA and csQCA are considered in relation to the balance of consistency and coverage. The robustness of the results of the truth table algorithm depends on the balance of consistency and coverage. Using poverty reduction as a dependent variate, we compare the two methods which are both useful.

Keywords and phrases: Fuzzy Set, Poverty Reduction, Pluralism

1. Introduction.

Uniform economic policy models based on the Washington consensus have failed to consistently bring economic growth to developing countries. The trickle-down theory suggests that growth in average incomes will gradually reduce poverty of the poor. However, whether growth represented by GDP per capita penetrates to the bottom remains in question. The income share of the poorest 20 per cent quintile in gross domestic product per capita using 1995 US dollars, over 1992 to 2002, shows that the poorest people did not necessarily benefit from economic growth in terms of national average GDP per capita.

The post-Washington consensus focused upon growth theory has sought causes that affect growth outside of uniform development policies: Governance, government's investment in its people's human capital, and civil liberties have all come under scrutiny as possible ways to move a country to

a higher output trajectory. Countries which are more neoliberal may have or may not have been successful in poverty reduction. Empirical evidence suggests that other socio-economic policies together with neoliberal economic policies play a significant role in poverty reduction (see literature review below).

The application of the QCA method is appropriate for a poverty study. Linear regression would study whether neoliberal economic policy is effective for poverty reduction when other factors or things are held equal, *ceteris paribus*. However, this approach alienates each factor that might contribute to poverty reduction and instead singles out only the type of cause which is universal across countries, and so may not be fruitful. The regression result using the data which are central to this study, for example, shows that economic growth is the sole contributor to poverty reduction (see Appendix 2). However, this conclusion may not necessarily lead to fruitful policy implications. It may rather raise a further question whether economic growth solely contributes to poverty reduction, or whether it requires other factors such as non-neoliberal policies, too. The application of csQCA and fsQCA allows us to consider other contributing factors which are woven into the causal mechanisms.

Further, in regression, cases are considered to be placed on a linear continuous measure. However, each level and degree of each condition can have meaning and impact. For example, levels and degrees of neoliberalism vary across countries according to the extent to which a country applies neoliberal economic policies in different sectors and layers of its population (an obvious example being direct taxes). Some countries' economic policies are fully neoliberal and others are not, but most of the time, their policies are somewhere in between. Similarly, levels and degrees of poverty reduction vary across countries. There is no absolute measure of poverty reduction. Application of fsQCA can capture this issue of different levels and degrees of conditions.

The purpose of the paper is a sensitivity assessment of the outcomes resulted from fsQCA and the ones from csQCA. Following Skaaning, this paper applies csQCA and fsQCA to the same dataset as a means of methodological triangulation where a particular research question is subject to a multi-method test (2007). It is useful to assess the robustness of the research results using both csQCA and fsQCA which are derived from the same dataset.

In Section 2, it reviews csQCA and fsQCA methods. Section 3 sets out the background of the poverty reduction study, followed by research design which describes the calibration process of variates for this study in Section 4. The concept of coverage and consistency is discussed in detail. In Section 5, the results of both csQCA and fsQCA are reported and in Section 6, the two results are discussed.

2. Fuzzy-set QCA and Crisp-set QCA

The work of Ragin (1987, 2000) has developed QCA as an empirical scientific effort to operationalise comparative study using a set-theoretic approach. Qualitative Comparative Analysis

(QCA) is the analysis of multiple conjunctural causation for set-theoretic relations. It means, firstly, more than one cause conjuncturally work together to bring about an outcome. Secondly, more than one set of such conjunctural causes exist which could lead to the same outcome. There are three particular features of QCA that are distinctive, and it is worth addressing each of these features to understand the method.

The first feature of QCA is the comparative nature of the method. Comparative social research has a long history, including Theda Skocpol's substantial studies of comparative historical trajectories and prior conditions for state breakdown (1979). The comparative study of politics has included researchers' social scientific inquiry of past events as well as trajectories of the future of countries of interest. Berg-Schlosser applied a cross-sectional longitudinal methods to seek conditions leading to authoritarianism, fascism and democracy in inter-war Europe (Berg-Schlosser 1998). Levi-Faur (2002) applied a step-wise method to examine cross-sectoral and cross-national variations in regulatory reform. Efforts in these analyses were set to keep the number of cases without compromising on the strength of case-oriented analysis based on rich qualitative information. In other words these were not standard statistical studies.

The second feature of QCA is the application of Boolean algebra and logic (i.e. the use of and/or)[1)]. Boolean logic is a logical calculus of truth tables and traditionally takes a form of dichotomy (i.e. 1 or 0). The Boolean approach can be found as early as in John Stuart Mill's work which shows his attempt to systematize comparative inquiries with the method of agreement and difference (Mill 1967 [1843]). Then, with the use of Boolean minimisation we can reduce a long, complex expression into a shorter, more parsimonious expression (details found in Rihoux and Ragin 2008) which is applied from library catalogue search to Internet search engines and helps which is called Boolean minimisation. Basically, the presence of A, B and C (A*B*C) and the presence of A, B and absence of c (A*B*c) produce the same outcome, C can be considered irrelevant and removed to create a simpler, combined expression (Ragin 1987: 93) With application of Boolean minimisation, QCA examines heterogeneity of cases' different causally relevant conditions and contexts.

The third feature is the analysis of set-relation. This feature clearly makes the QCA method distinct from conventional quantitative methods and differentiates itself from the analysis of correlation. Set theoretic connections are asymmetrical in nature. In the set-theoretic claim, neoliberal countries with successful poverty reduction do not mean that non-neoliberal countries cannot reduce poverty successfully. The first claim is that countries with full neoliberal economic policies had poverty reduction. The second claim is that countries with a lesser degree of neoliberal economic policies together with other socio-economic policies had poverty reduction. Here, this example illustrates that the first claim is not refuted by the existence of the second claim, where several different combinations of conditions are sufficient for the same outcome.

The forth and final feature is combined effect of causation as compared to net effect of causation. Association of theoretical attributes (causal conditions) of cases and particular conditions(s) of interest (outcome(s)) creates subset relations of conditions and outcomes (Ragin 2000). In

recognition of the set-theoretic connections, QCA allows for multiple conjunctural causation determining the number and character of the different causal models that exist among comparable cases.

So, what makes the fsQCA different from traditional csQCA? It is the consistency cutoff point. In principle, csQCA does not allow contradiction. Thus the consistency cutoff is always 1. On the other hand, fsQCA is more flexible; it allows some degree of 'inconsistency' at various cutoff points. The cutoff points are calculated by consistency and coverage of each multiple conjunctural causation. The determination of the cutoff consistency should depend on: 1) the number of case you have (the less the cases, the more data-sensitive to determine the cutoff point for the outcome); 2) the richness of data.

The second point can be explained as the csQCA allows examining difference in kind whereas the fsQCA allows examining difference in kind and degree (Ragin 2000). For csQCA, the focus is on specific kinds of cases. According to specific kinds, cases are coded either 1 or 0. For example, our focus in this study is on the concept of the specific kinds of countries which shows whether the income of the poorest population improved between 1992 and 2002 or not. It would be coded 1 if the difference of the income of the poor in 2002 is greater than that of 1992 and coded 0 if the difference is less than 0. When you have more detailed information on each case, you can be more precise the kind of cases and consequently the consistency becomes 1.

For fsQCA, on the other hand, the focus is on both specific kinds and degrees of cases. To determine degrees, determining breakpoints require more knowledge of what constitutes each degree of conditions. Measures are calibrated on the degree to which cases satisfy membership criteria (Ragin 2008). Membership criteria mean putting meaning to each level of the membership for the change of income over time. Thus, this paper explicitly explains how each condition was calibrated.

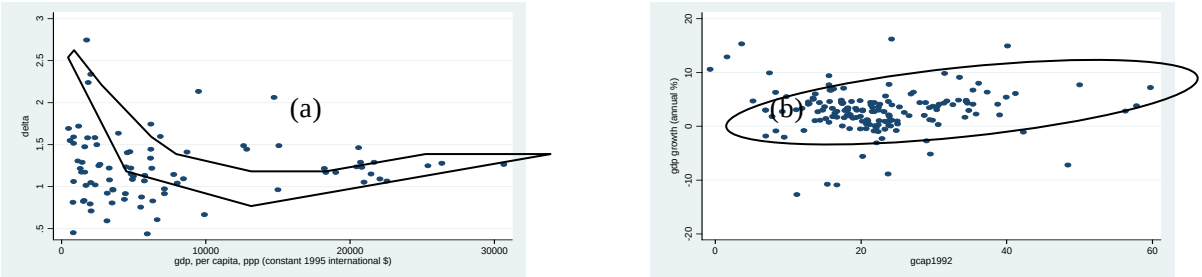
To conduct sensitivity analysis, the main focus has been on calibration of variables. However, as we discussed earlier, the key difference between csQCA and fsQCA is the cutoff point. Thus, in our assessment of the outcomes, we focus on the determinacy of the cutoff point for our outcome, improvement of the income of the poorest population between 1992 and 2002.

3. Background of the study

In recent years, the theory of growth was transformed by the switch from Structural Adjustment Programmes (SAPs) to a post-Washington Consensus focus. SAPs aimed to ensure that each country avoided balance of payments crises and could continue on its growth path. But many countries, notably in Africa and some in Latin America, were considered to have failed SAPs and the free-market supply-side consensus has been severely questioned as a result. In the post-Washington Consensus, consistent with Barro's work on the intermediate social and political factors affecting growth, institutional factors are considered relevant (2000). Governance, government's investment in its people's human capital, and civil liberties have all come under scrutiny as possible ways to move

a country to a higher output trajectory. Recent studies of the quality of government spending have argued that a rational government will make strategic use of its national debt and tax revenue (Henderson, Hulme et al., 2007). You and Kaugram (2005) illustrate this type of investigation, still using statistical methods. Booth (2003) asks whether it might not make more sense to seek country-specific solutions to poverty problems, rather than approaching the countries as a set and looking for one global pattern. The universalism that is implicit in the statistical method can be shown diagrammatically. In any underlying scattergram, the econometric method is seeking to find either linear or curved 'lines of best fit' by minimising error around them; Figure 1 illustrates two of these.

Figure 1: Illustration of Lines of Best Fit



Note: Panel (a) shows poverty reduction 1992-2002 by GDP per capita in 1992. Using the log of GDP, one may try to fit a curve to the data. Panel (b) shows the GDP growth rate 1992-2002 by the investment rate in 1992. The positive slope shown emerges as significant in panel data fixed-effects regressions in spite of the looseness of its fit. See Appendix 1 for details of variables and sources.

Ironically, to make matters worse, when economists delve into areas of social arrangements (e.g. religion), political systems (e.g. voting systems), and governance (e.g. corruption), they appear to assume that such concepts when operationalised and measured have one single value across countries and the value is assumed to contain the same meaning. The real diversity of the world's societies is beyond the awareness of the modeller. For a sociologist the harmonisation is an act of putting unlike with like, forcing situations to fit one general global concept (e.g. political freedom). Many turn away from these statistical results, and use other methods instead. Fuzzy set causal analysis is a method that can help researchers to use mixed methods to understand small groups of countries better.

After all, in the post-Washington Consensus, institutional difference makes different groups of countries really fundamentally different. An awareness of the failure of global models has made Stiglitz, for example, disassociate from the Washington Consensus (Stiglitz, 2002). Institutionalism has many facets. Among these, some aspects of interest are gender related, some are historically grounded, and some are structuralist. See Walby (2005) and Grown, Elson et. al. (2000) for a discussion of gender differences across countries. See Ekstrom (1992) for a general discussion of how structures create detailed nuances within cases (not just between them). Kanbur has appealed for

an awareness of country diversity (2002). Institutionalism as it now exists is moving rapidly toward a serious form of realist structuralism. Its neoclassical form (new institutional economics) can be confusingly idealist and utilitarian, but other forms are emerging. A long-standing tradition of structuralist macroeconomics argued that the different sector-sizes, response-speeds, and trade-dependencies made each country almost a unique case. (e.g. j-curve debate; coffee and fair-trade experiences); see (Taylor, 1983, 1988; Harrigan, 2001 is a case-study).

Some studies in geography are of this pluralist, interdisciplinary kind that institutionalism seeks, e.g. (Norton, 2003). These are rather simple econometrically but rich in descriptive power and strong on “realism” in the sense of correspondence to local realities. The recent research tends to question the bland and blithe claims that certain authors have made, e.g. Dollar (2001) is opposed by Weiss (2008); and Edwards (2006) questions the simple logic of Milanovich that poor countries can grow out of poverty.

Our movement forward is to re-explore some data using fuzzy sets. Our research is exploratory since the method is relatively new. Fuzzy set analysis has recently been entered into STATA software but is not present in SPSS software, and we have used the well-established FS QCA and TOSMANA software to implement fuzzy set analysis. We use a retroductive frame for the moment (Danermark, et al., 2001), asking what must have been the case for countries which experienced improvement in income share of the poorest 20 % quintile in terms of gross domestic product per capita during the period 1992-2002. However hypothesis testing does come into this since there are some well-established economic claims about how capitalism works, which we do not need to challenge (rather, we are augmenting them).

4. Analysis

4.1 Data used

The data were collected from several locations and both definitions of the variables and their sources are found in Appendix 1. The poverty reduction measure, and their underlying lowest quintile of income in terms of GDP per capita, was made available in the work of Edward (2006). The outcome is degree of membership in the set of countries which showed an improvement in the income share of the poorest 20 % quintile in gross domestic product per capita using 1995 US dollars, over 1992 to 2002 (DELTA). The causal conditions are degree of membership in the set of countries with good economic growth in the period around 1992 (GDPPCRATE92), degree of membership in the set of countries with high government spending at that time (GOVTEXP92), degree of membership in the set of countries that were experiencing inequality during that period (GINI93), degree of membership in the set of countries with a high rate of female labour force participation (ILOLFPF92), and degree of membership in the set of countries with female school attainment a decade earlier (ATTAINF82) in order to see the time effect of female attainment on female labour force participation. Due to the limited data available for attainment rate of 1982, the case number is 37.

The fuzzy membership scores were calibrated using indirect method (Ragin 2008). Also, measures were calibrated on the degree to which cases satisfy membership criteria (Ragin 2008). Membership criteria mean putting meaning to each level of the membership for the change of income over time. In fuzzy set, each interval has meaning depending on how each fuzzy set is conceptualised and labelled. Instead of seeing delta as just ordinal measurement, we see it has a cardinal point of measurement. Thus, this paper explicitly explains how each condition was calibrated.

Data was calibrated using threshold setter in TOSMANA (Cronqvist, 2007). TOSMANA is powerful in terms of visualisation and also when re-scaling the interval-scale indicator to reflect knowledge-based, qualitative groupings of cases, categorised according to degree of set membership. The “thresholds setter” function in TOSMANA aids researchers not only to set thresholds but also to adjust the thresholds according to one’s knowledge and theoretical information. Also, this study takes an extra caution toward using the membership of 0.5. In Ragin’s term, 0.5 is neither in nor out. The cluster point is the value of the interval-scale where there is maximum ambiguity as to whether a case is in or more out of the target set (Ragin 2008). However, there are cases where the cross-over point has a clear meaning. In the case of GDP per capita rate for example, greater than 0 means growth rate is greater than the previous year.

Another disadvantage of setting the membership score of 0.5 is that the cases which have the 0.5 membership are excluded from the truth table number column. There are two stages of the dropping of cases. The first stage of dropping of cases occurs, like any statistical analysis, with those cases with missing values of the five causal conditions. Then the second stage of dropping of cases occurs when condition values of 0.5 are omitted from the truth table. It could be a serious matter as fsQCA is intended to be applied to Small-, Medium-N studies. Thus, in this study, we consider that more than 0.5 is considered as clearly in and we put 0.51 instead of 0.5. It can be resolved by putting the 5 cut points (0, 0.2, 0.4, 0.6, 0.8, and 1) in order to avoid using 0.5. The cut point of 0.6 for delta means income of the poor showed improvement over time. The membership of 0.6 is set at 1 where greater than 1 means income improved over time. It will affect the consistency and coverage score; however the result will be similar.

DELTA

For our comecome variable, DELTA, we took data of the income of the poorest population from two time points, 1992 and 2002. This way, we can see whether it improved over time and we can use it as a measurement of its improvement across countries. This is one approach of time-series fsQCA summarised by Hino (in this special edition). For both fuzzy and crisp set, delta was calibrated from the concept of whether some degree of improvement was seen in terms of the poorest population’s income. In other words, the income share of the poorest 20 % quintile in terms of gross domestic product per capita had shown an improvement between 1992 and 2002. For that reason, when delta is greater than 1, it was considered that some degree of poverty reduction is happening and delta was calibrated accordingly. As shown in Appendix 3, delta ranged from 0.437 of Venezuela to 2.744 of

Kyrgyzstan. With the thresholds of 6 with cluster effect, delta had a threshold of 0.52, 0.73, 0.99, 1.37, 1.9 and 2.54.

GDPPCRATE

GDP per capita rate (gdppcratef) is growth of GDP measured in local units of currency, adjusted for population size (annual percentage). GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. GDP per capita is often used as a proxy as the country's economic development. GDP per capita rate represents annual growth. It is useful to capture GDP per capita annual growth rate of a particular year, i.e. 1992. On the other hand, the interpretation of numbers has to be cautious as it does not reflect long term growth. Thus, we refer to GDP per capita average annual growth rate of 1990-2007 which is available from UN data when we discuss our results.

The 1992 GDP per capita growth rate ranged from -44.70745 of Georgia to 12.85 of Jordan. The threshold for full-membership and non-membership was determined according to cluster when six thresholds were set, i.e. -19.29 and 8.29. Other thresholds were determined where there was a clear gap in cases. The membership of 0.17 was cut at -5.6. The membership of 0.33 was cut at -0.5 since there was a clear gap. Most independent states from the former USSR including the Russian Federation struggled with GDP per capita growth in the early 1990s and they fall into this category. The membership of 0.51 was made at -2.77. Many developed countries fall in this category because growth rates of matured economies slow down. The membership of 0.67 was made at 5.53 which naturally fallen in between the membership of 0.51 and the membership of 0.83 at 8.29.

GOVTEXP1992

The government expenditure is expressed as % GDP. The 1992 government expenditure ranged from 8.04 of China to 69.3 of Kuwait. The threshold for full-membership and non-membership was determined according to cluster when six thresholds were set, i.e. 16.18 and 45. The membership of 0.17 was cut at 20.69 and that of 0.33 was cut at 25. The membership of 0.51 was made at 31.67. The average of government expenditures of the developed countries is 37 per cent of GDP. This matched with the cluster point of 38.32 for the membership of 0.67. The membership of 0.83 was cut at 45 where there was a clear gap.

GINI

The Gini coefficient is the measure of economic (income or expenditure) inequality between countries, where 1 is maximum inequality and 0 is equality. Although inequality exists within countries, the differences of inequality between countries are larger (Milanovic 2002). We use the Gini coefficient as a measure of within-country inequality to compare the level of inequality across countries. The Gini coefficient is extracted from Edward's paper (2006). His Gini data for 1993 was survey results from proximate years within three years on either side of the year in question which

was compiled by the World Bank. The Gini for 1993 ranged from 19.5 of Slovakia to 63.4 of Brazil. When the Gini coefficient is about 0.3, it is considered as relatively low equality; about 0.4, the equality is relatively moderate; and 0.5 or above it is considered as high inequality. Thus, it was calibrated 23, 29.5, 36.5, 44.3, 52.2, and 60.

ILOLFPF

The labour force participation rate is a measure of the proportion of a country's working-age population that engages actively in the labour market (ILO 2007). The variable ILOLFPF is the ILO estimate of the proportion of the workforce that is female. (female labour force participation rate) -dated on a 3-year period centred on 1990. During the 1980s and 1990s women's participation in labour markets worldwide increased significantly, which reflects increased opportunities and economic autonomy for women. In relation to poverty reduction, female labour force participation is considered to be positive at both macro and micro level. At the macro level, female labour force contributes overall GDP per capita of the country. At the micro level, women's economic autonomy has an immediate positive impact on distribution of food and other basic needs within intra-household. While acknowledging that power relations and allocation of resources within intra-household is more complex (Kabeer 1997; Deshmukh-Ranadive 2005), this paper takes the position that women's labour force participation has a positive impact on poverty reduction.

Although we used female labour force participation rate from ILO data which is the best possible way to capture membership of female work participation, female labour force participation is under-reported. In developing countries especially, both males and females engage in multiple economic activities. For example, there is a very small proportion of females who are considered as full-time mothers. Thus, recording only main economic activity captures only a partial picture of labour force participation. The 1992 female labour force participation ranged from 6.42 percent to 54.96 percent. The 6.42 per cent is the female labour force participation of Oman and 54.96 per cent is that of China. The threshold for full-membership and non-membership was determined according to cluster when six thresholds were set, i.e. 14.98 and 49. Other thresholds were determined where there was a clear gap in cases. The membership of 0.17 was cut at 25.43 where interestingly many Latin American countries are grouped. The membership of 0.33 was cut at 31.21 since there was a clear gap and when you see cases 31.21 was Belgium and it was reasonable to group it together with its neighbour country of Luxembourg, 30.6. The membership of 0.51 was made at 37.1 where also there is a reasonable gap. The membership of 0.67 was made at 43.1 which naturally fell in between the 0.5 membership and the full membership at 49.

ATTAINF

ATTAINF is the educational attainment rate of females. The human capital theory suggests that education and training are important factors of employment and earnings (references). The educational attainment rate was taken from 1982 data. The reason is that those females who attained

their secondary education level in 1982 will have been part of the labour force for at least since 10 years if they started working after attaining the secondary education and for at least 5 years if they worked after obtaining college education. This 10 year gap considers job skill training and other diplomas. We considered that those who are in the work force to contribute to the household and the countries economy would be around 30 years old. We specifically use the female attainment rate, as the overall attainment rate of both male and female does not adequately represent attainment rate in general. For example, Nepal has 0.91 of attainment rate overall, however only 0.21 of attainment rate for females which is second lowest attainment rate of data available. More importantly in his panel study, secondary and higher attainment of females was insignificantly contributing the growth (Barro 2000) and we wanted to test this within the application of fuzzy-set.

The 1982 female educational attainment rate was ranged from 0.066 of Yemen to 11.82 of the United States. The threshold for full-membership and non-membership was first determined according to cluster when six thresholds were set, i.e. 2.82 and 10.74. However, since data is skewed towards left and if it is clustered at 2.82, 39 cases are categorised as non-membership. On the other hand, there was a clear gap between those which were less than 0.7 and more than 1. Thus, the 0.17 and 0.33 memberships were cut at 0.7 and 2.82. Similarly, the full membership was created according to the gap at 8.99. Remaining membership fell in between where there are clear gaps. The 0.51 membership was cut at 4.8, the 0.67 membership at 6.19 and the 0.83 at 7.58.

4.2 Assessment Procedure

To construct the truth table, fsQCA lays out all logically possible combinations of conditions which are considered, including those without empirical instances. The consistency score for a configuration is a measure of the subset relationship. QCA examines the extent to which particular causal factors or configurations are subsets of the outcome, and the consistency score measures this subset relationship. Consistency is thus a measure of the extent to which membership strength in the causal configuration is consistently equal to or less than membership in the outcome (Epstein et. al, 2007: 10).

For each configuration (row in the truth table), minimum membership scores (causal combination intersected with outcome) are added for all cases. This number is divided by the sum of all minimum membership scores in the causal combination. The formula of consistency is:

$$\text{Consistency } (X_i \leq Y_i) = \Sigma (\min (X_i, Y_i)) / \Sigma (X_i).$$

This formula uses fuzzy-set mathematics. The min(X) is the intersection (“AND” or ∩) of all X. Σ(X) is the union (“OR” or ∪) of all X. When membership in outcome Y is less than membership in causal configuration X, the numerator will be smaller than the denominator and the consistency score will decrease. “Consistency scores range from 0 to 1, with 0 indicating no subset relationship and a score of 1 denoting a perfect subset relationship (Epstein et. al, ibid: 10).”

On the other hand, coverage refers to the proportion of the sum of the membership scores in an outcome that a particular configuration explains. In other words, it explains how many cases are covered with the sufficiency configuration for outcome Y. The high coverage score indicates that the configuration is consistent with the outcome and it has many cases with the configuration outcome "in", while low coverage scores indicate that even if the causal configuration is consistent with the outcome, it is substantively trivial. Studying coverage scores helps us in avoiding spurious configurations for the chosen outcome.

Coverage ($Xi \geq Yi$) = Σ (min (Xi, Yi)) / Σ (Yi).

The table 1 shows the truth table and Appendix 3 provides the raw data table. The number of combinations is 2^k, where k is the number of causal conditions. With five causal conditions, there are 32 logically possible combinations of conditions. After creating a truth table by specifying the outcome and the causal conditions, frequency cutoff must be determined. It is suggested that when the total N is large, the frequency threshold should be defined (Ragin 2005). In this study, frequency cutoff was set at 2. Next is the selection of a consistency cutoff. The purpose is to distinguish causal combinations that are subsets of the outcome from those that are not. Consistency is the measurement for whether the degree of membership of each causal combination is supported by the empirical evidence (i.e. set-theoretic relationship).

Ragin suggests that *yconsist* (written 'consist' in the truth table) values less than 0.75 are considered substantially inconsistent (Ragin 2000; 2005; Rihoux and Ragin 2008: 147). In general, consistency scores should be as close to 1.0 (perfect consistency) as possible. This is consistent with the probabilistic test with a benchmark value of consistency at 0.80 and an alpha at 0.05 as significance. However, all sub-sets of the configuration could have the score of *yconsist* more than 0.75 if the degree of membership in the sub-set is higher in a subset of membership in the outcome.

Also, Ragin (2000) suggest that for the best judgement of selecting consistency cutoff, you can sort the consistency scores in descending order and observe whether a substantial gap occurs in the upper ranges of consistency scores. However, as you can see in Table 1, the consistency score is much higher than 0.8 and there is no obvious gap. Unless you decide on a consistency cutoff you cannot do the analysis. On the other hand, the right cutoff point could provide an accurate result. Thus, determining the right consistency cutoff is important. In this case, the solution coverage and the solution consistency help us in finding the right consistency cutoff point.

Table 1: Truth Table of the Fuzzy Sets: Causal Sufficiency for Improvement in Income of the Poor

gdppcrate92f	govtexp92f	ilolfpf92f	gini93f	attainf82f	number	deltaf	consist
1	1	1	0	1	6	1	1
1	1	0	0	0	3	1	1
1	1	0	1	0	3	1	1
0	1	0	1	0	2	1	1
0	1	1	0	1	2	1	1
1	0	1	0	1	2	1	1
1	0	0	0	0	2	1	0.981088
1	0	1	1	0	3	1	0.978049
1	1	0	0	1	2	0	0.968366
1	0	1	0	0	3	0	0.941246
1	0	0	1	0	3	0	0.938752

Note: the membership of deltaf is inserted by the author at the consistency cutoff point of 0.978

4.3 Consideration of solution coverage and solution consistency

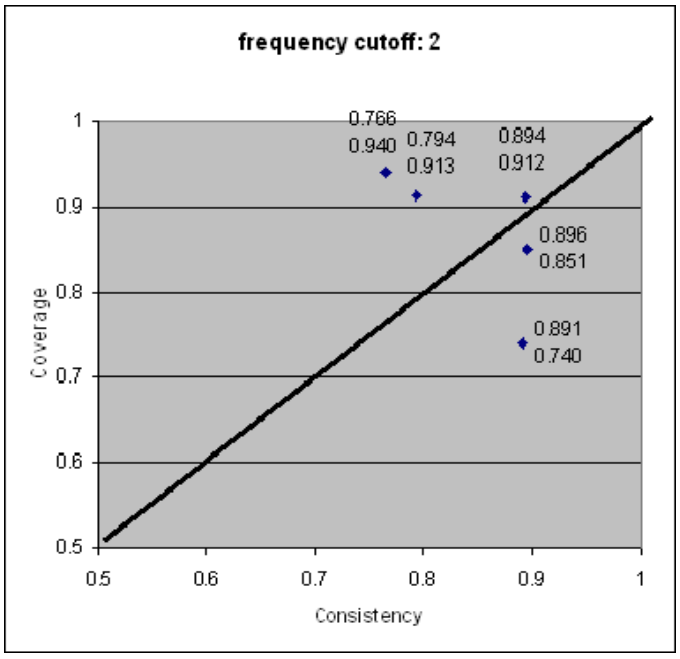
The first obvious cutoff point is 1. After running a standard sufficiency analysis, you get results with solution coverage and solution consistency. Then, you can run the analysis by lowering the cutoff points. After obtaining the solution coverage values and solution consistency values for each result, you can see the relationship of consistency and coverage of the total configurations. Table 2 shows the results. Also, Figure 2 shows the relationship of consistency and coverage. In the figure, consistency is on the x and coverage on the y. This is consistent with the idea of Ragin (2006: 292) that ‘consistency assesses the degree to which instances of an outcome agree in displaying the causal condition thought to be necessary, whereas coverage assesses the “relevance” of the causal condition-the degree to which instances of the causal condition are paired with instances of the outcome’.

Table 2 Consistency and Coverage Levels, Causal Sufficiency Tests

frequency	Cutoff point	consistency	coverage
2	1	0.891	0.740
2	0.981088	0.896	0.851
2	0.978049	0.894	0.912
2	0.968366	0.794	0.913
2	0.941246	0.766	0.940

Note: rounded at three decimal points.

Figure 2: Figure Showing Consistency Measure for Causal Sufficiency



In the plot of membership in the outcome (Y) against membership in a causal condition or combination of causal conditions (X), consistency is defined as the proportion of cases on or above the main diagonal of the plot (Ragin 2000). Each configuration of combination of causal conditions is plotted on the figure according to their solution coverage and solution consistency. A set relation is established if significantly greater than 80 per cent of the cases fall on or above the main diagonal, it can then be argued that 'the cause or causal combination X is "almost always" sufficient for the outcome Y' (Ragin 2006: 295). Similarly we can argue that significantly greater than 80 per cent of the configurations' coverage falling on or above the main diagonal can be seen as a sign of the multiple conjunctural configurations and is almost always sufficient for the outcome Y.

We can see the relationship of consistency and coverage of the set of all configurations (pathways) to poverty reduction. When cutoff point is 1, consistency is 0.891, but coverage is low at 0.740 which means the combination of configurations only covers below 80 percent of cases. When consistency cutoff point is lowered to 0.981, consistency increases slightly to 0.896 and coverage increases to 0.851. Similarly, the consistency cutoff point is 0.978, consistency slightly decreases to 0.894, but the coverage remarkably improves to 0.912. However at the consistency cutoff point of 0.968, consistency drops significantly to 0.794 while coverage is more or less the same at 0.913. Similar results were found at 0.941, those consistency drops to 0.766 while coverage is better only slightly. Thus, the result we represent below is the discussion of the point; one point just above the above diagonal line (consistency solution: 0.894, coverage solution: 0.912).

5. Results

5.1 fsQCA result

FsQCA presents three solutions to each truth table analysis: (1) a “complex” solution that avoids using any counterfactural cases (rows without cases - “remainders”); (2) a “parsimonious” solution, which permits the use of any remainder (for combinations of conditions which have few cases or that lack cases to be included) that will yield simpler (or fewer) recipes; and (3) an “intermediate” solution, which uses only the remainders that survive counterfactural analysis based on theoretical and substantive knowledge. Generally, intermediate solutions are considered as the best solution. Regression of this model is provided in Appendix 2. The results derived the intermediate solution at the consistency cutoff of 0.978 (consistency solution: 0.895, coverage solution: 0.921) is shown in Table 3.

Table 3: Truth Table Analysis With Frequency Cutoff of 2 and Consistency Cutoff 0.978

	Raw coverage	Unique coverage	Consistency
attainf82*GOVTEXP92	0.562	0.064	0.958
gini93*ILOLFPF92*GOVTEXP92	0.478	0.027	0.878
ATTAINF82*ILOLFPF92*GDP92	0.479	0.010	1.000
GINI93*ILOLEPF92*GDP92	0.509	0.052	0.982
attainf82*gini93*ilofpf*GDP92	0.567	0.068	0.986

The table shows the calculation of both raw and unique coverage of each combination. The raw and unique coverage linked to an outcome is very useful as it not only reveals coverage of each configuration but also its relative empirical weight (Ragin 2006). This calculation is very useful when there are many different paths to the same outcome. Raw coverage assesses ‘the relative importance of different combinations of causally relevant conditions’ (Ragin 2006: 305): the proportion that a configuration covers the outcome. It is calculated by the sum of consistent scores of the configuration divided by the sum of outcome scores. On the other hand, unique coverage assesses the weight of the configuration: the proportion that uniquely covers the outcome. Unique coverage is calculated by the coverage of a configuration of interest from the set of configurations minus the raw coverage of configurations without the particular configuration of interest.

The highest raw coverage is attainf82*gini*93*ilolfpf*GDP92 which cover 56.7 per cent of the instances of the outcome, delta, the improvement of income among the poorest population followed by another pathway to poverty reduction, 56.2 per cent of attainf82*GOVTEXP92. The unique coverage of each of them is 6.8 percent and 6.4 per cent respectively; 6.8 per cent of the instance of poverty reduction is uniquely explained by the absence of attainf82, inequality in 1993, and female labour force participation accompanied by the presence of strong national growth rate. On the other

hand, 6.4 per cent of the instance of the income improvement of the poorest population is uniquely explained by the absence of attainf82 accompanied by the presence of government expenditure.

However, this is a partial picture of the pathways to poverty reduction because the other three pathways to poverty reduction reveal that the presence of female school attainment rate and female labour participation can also contribute to poverty reduction under difficult circumstances. However the weight of the pathway could be less as the three pathways cover more than 47 per cent of the instances of the outcome, delta. It is important to keep in mind that in fuzzy analysis, we are finding out the diverse combinations of causes that contribute to the same outcome.

The second pathway, gini93*ILOLFPF92*GOVEXP92 shows that the absence of inequality together with the presence of female labour force and government expenditure contributes to the outcome. This pathway implies that when economic inequality is not there women have more opportunity to work with the provision of government programmes and that together helps improve the income of the poor. The third pathway, ATTAINF82*ILOLFPF92*GDP92 is the presence of female attainment, female labour force participation, and economic growth. This implies that when a society provides enough economic activities as a result of economic growth, there is more opportunity for females who had a higher level of school attainment in the labour force. The fourth pathway, GINI93*ILOLFPF92*GDP92 is the presence of inequality, female labour participation, and economic growth. We can interpret this as even if inequality is prevalent in society, the presence of female participation together with the drive of economic activity can improve the poor population’s income.

5.2 Exemplars of configurations

First, we discuss cases in the configuration of attainf82*GOVTEXP92 in Table 4. This table shows a variety of countries. These countries experienced the presence of government expenditure contributed to the improvement of the income consumption of the 20 per cent poorest population. The attainment of females was simply absent. Furthermore, except in Zambia, female labour participation was absent. Also when women are poorly educated, the available labours are often manual. This encounters a strong social stigma against women to participate in the labour force if not necessary (Goldin 1994). Also, countries such as Egypt, Yemen and Tunisia have culturally recoded low female educational attainment as fewer females enrolled in the 1980s. Interestingly, Spain and Italy of OECD member countries marked high government expenditure with low female attainment to contribute to the outcome, delta. Noticeably, Brazil, Zambia and Nicaragua achieved poverty reduction without economic growth. With the presence of inequality, these three countries saw an improvement of the income distribution to the lowest 20 per cent implying that the content of government spending played a role in the outcome.

Table 4 Cases of attainf82*GOVTEXP92

country	deltaf	gdppcrate1992f	govtexp1992f	gini1993f	ilofpf1992f	attain1982f
Spain	0.67	0.51	0.67	0.83	0.33	0.33
Italy	0.51	0.51	1	0.33	0.33	0.33
Sri Lanka	0.67	0.67	0.51	0.33	0.33	0.33
Brazil	0.51	0.33	0.51	1	0.33	0.17
Zambia	0.51	0.33	0.51	0.67	0.51	0.17
Nicaragua	0.67	0.33	0.51	0.67	0.17	0.17
Tunisia	0.67	0.83	0.67	0.51	0.17	0
Yemen	0.67	0.67	0.51	0.51	0.17	0
Egypt	0.51	0.51	0.83	0.33	0.17	0

The list of countries with the second pathway is shown in Table 5. When inequality is absent, government spending can improve the income of the poor with the presence of high female labour force participation and high female school attainment. These traditionally socialist countries achieved poverty reduction in this configuration. In fact all countries with this configuration also have a high female school attainment rate. Except for Hungary and Finland, they all had the presence of moderate economic growth at the fuzzy membership of 0.51.

Table 5 Cases of gini93*ILOLFPF92*GOVTEXP92

country	deltaf	gdppcrate1992f	govtexp1992f	gini1993f	ilofpf1992f	attain1982f
United Kingdom	0.51	0.51	0.83	0.33	0.67	0.67
Netherlands	0.51	0.51	1	0.33	0.51	0.67
Denmark	0.51	0.51	0.83	0.17	1	0.67
Poland	0.67	0.51	0.83	0.17	0.83	0.67
Norway	0.51	0.51	0.83	0.17	0.83	0.67
Belgium	0.51	0.51	1	0.17	0.51	0.67
Hungary	0.67	0.33	1	0	0.67	0.67
Finland	0.51	0.33	0.83	0.17	0.83	0.51

The next configuration in Table 6 is the presence of female school attainment in 1982 and female labour force participation together with economic growth. The countries with this configuration are all OECD member countries. Notice that cases in this set of configuration overlap the cases of the previous configuration except the United States, Japan and Republic of Korea. With a low proportion of government spending, these three countries achieved poverty reduction with mainly economic activities with the presence of female school attainment and female labour force participation. When

economic growth increases, so does inequality as the gap between economic winner and loser widens. However, with this set, it was not the case, except in the United States.

Table 6 Cases of ATTAINF82*ILOLFPF92*GDP92

country	deltaf	gdppcrate1992f	govtexp1992f	gini1993f	ilofpf1992f	attain1982f
United States	0.51	0.51	0.33	0.67	0.83	1
United Kingdom	0.51	0.51	0.83	0.33	0.67	0.67
Netherlands	0.51	0.51	1	0.33	0.51	0.67
Denmark	0.51	0.51	0.83	0.17	1	0.67
Poland	0.67	0.51	0.83	0.17	0.83	0.67
Norway	0.51	0.51	0.83	0.17	0.83	0.67
Japan	0.51	0.51	0.33	0.17	0.67	0.67
Belgium	0.51	0.51	1	0.17	0.51	0.67
Korea(Rep. of)	0.83	0.67	0.17	0.33	0.51	0.51

The next configuration in Table 7 shows that even in those countries which experience inequality in society, the presence of female labour participation with economic activities captured by economic growth shows a reduction in poverty. In Jamaica, the role of females in the labour force is well known. Over a third of the households are headed by women. Female is the main force of economic activities at large and the main contributors at the level of the household (Bolles 1983). In Thailand, the percentage share of women in non-agricultural employment is more than 40 per cent and the labour force in the agricultural sector is quite high although all farm women are counted as unpaid family helpers (Dixon 1982). As the full membership of female labour force, China ideologically encourages female equal participation in the labour force. Even taking into account the inequality of rural and urban areas in these countries, the outcome shows they achieved poverty reduction through improvement in the poor population's income.

Table 7 Cases of GINI93*ILOLFPF92*GDP92

country	deltaf	gdppcrate1992f	govtexp1992f	gini1993f	ilofpf1992f	attain1982f
United States	0.51	0.51	0.33	0.67	0.83	1
Jamaica	0.33	0.51	0.33	0.51	0.83	0.33
Thailand	0.67	0.83	0	0.67	1	0.17
China	0.67	1	0	0.51	1	0.17

Finally, Table 8 shows the countries which improved the poor population's income with the final

configuration, attainf82*gini93*ilolfpf*GDP92. Even with the absence of female school attainment and female labour participation, when inequality is absent, economic growth brought improvement in poor population's income. Noticeably, Egypt, Italy and Sri Lanka were in the first configuration that also had high government expenditure. This implies that the presence of economic activities together the absence of inequality play a role in poverty reduction in these countries although these countries lack of women's educational attainment and women's participation in the labour force. Interesting cases are those of India and Pakistan, who had nonmembership and low membership of government expenditure. These countries improved the income of the poor with the absence of female school attainment, female labour force participation, as well as government spending.

Table 8 Cases of attainf82*gini93*ilolfpf*GDP92

country	deltaf	gdppcrate1992f	govtexp1992f	gini1993f	ilofpf1992f	attain1982f
Egypt	0.51	0.51	0.83	0.33	0.17	0
India	0.67	0.67	0	0.33	0.33	0
Italy	0.51	0.51	1	0.33	0.33	0.33
Pakistan	0.51	0.67	0.33	0.33	0.17	0
Sri Lanka	0.67	0.67	0.51	0.33	0.33	0.33

For India and Pakistan, we must take note that inequality does not mean they are all poor and similarly equality does not provide economic affluence. Differences between mean incomes of the population and the size of the population are the most important factors to shape inequality of the country. For example, when fuzzified, the Gini coefficient of both India and Pakistan is 0.33 which is the same fuzzy membership of the United Kingdom and the Netherlands. In the whole population, when poverty is prevalent and the population are equally poor, the Gini coefficient captures as 'equal'. Thus, India and Pakistan are two cases that seem to show that the economic growth solely provided poverty reduction. However, from our knowledge, we know that they are two of the main recipients of Overseas Development Assistance of state- as well as non-profit donors and so we may not simply conclude that the economic growth was the sole contributor of poverty reduction in these countries.

5.3 csQCA result: exemplars of configurations (csQCA results)

Now we turn to the crisp set QCA result. The crisp set was calibrated using the fuzzy set membership. After carefully calibrating the fuzzy set membership of the conditions, it was considered that greater than the fuzzy membership of 0.5 as presence of the condition. When, the truth table was created for the crisp set data, it was clear to make the consistency cutoff at 1.00 as shown in Table 9. Following the practice of the fuzzy set data analysis, frequency cutoff was made at 2.

Table 9: Truth Table of the Crisp Sets: Causal Sufficiency for Improvement in Income of the Poor

gdppcrate92c	govtexp92c	ilolfpf92c	gini93c	attainf82c	number	deltac	consist
1	1	1	0	1	6	1	1
1	0	0	0	0	2	1	1
0	1	1	0	1	2	1	1
0	1	0	1	0	2	1	1
1	1	0	0	0	3	1	1
1	1	0	1	0	3	1	1
1	0	1	0	1	2	1	1
1	0	1	0	0	3	0	0.666667
1	0	1	1	0	3	0	0.666667
1	1	0	0	1	2	0	0.5
1	0	0	1	0	3	0	0.333333

Note: the membership of deltaf is inserted by the author at the consistency cutoff point of 1.000

Notice that the result shown in Table 10 is almost similar to that of the fuzzy set data in Table 3. The only difference is that the configuration of GINI*ILOLFPF92*GDP92 disappeared from the crisp set data result. This is because Jamaica did not improve the income of the poor population. In the fuzzy set analysis, although Jamaica did not have the presence of the outcome, the other four countries were showing that the combination of conditions was the strong case (i.e. containing high consistency) as a pathway to the outcome. On the other hand, in the crisp set, it was considered as contradiction.

Table 10 Truth Table Analysis of the Crisp Set: frequency cutoff: 2 and consistency cutoff: 1.000

	Raw coverage	Unique coverage	Consistency
attainf82*GOVTEXP92	0.310	0.207	1.000
gini93*ILOLFPF92*GOVTEXP92	0.276	0.069	1.000
ATTAINF82*gini93*ILOLFPF92*GDP92	0.276	0.069	1.000
attainf82*gini93*ilofpf*GDP92	0.172	0.069	1.000

In fact, this result is identical with the fuzzy set result when consistency cutoff was made at 0.981. As we recall the 0.981 cutoff point placed below the diagonal line and the total coverage of the configurations dropped from 0.912 to 0.851. The difference is not simply whether we make the consistency cutoff at 0.981 or 0.978. What we might want to question is whether we would leave out the configuration of GINI*ILOLFPF92*GDP92 as one of pathways to poverty reduction or not. In

this study, it was considered that it was still worth investigating which case had gone through the pathway to the outcome despite the presence of inequality.

6. Discussion

With retroductive thinking, in this section we are asking what must be the case in order for this set of configurations to have occurred. A retroductive approach can avoid spurious association because we explicitly work through what causal mechanisms may be represented by the variates. It is neither a positivist reductive approach nor a traditional qualitative inductive approach. As we asked the question “what must have been the case for improving income of the poorest population,” we address some answers to the question..

First, the result from the fuzzy set analysis differs from that of the regression analysis. The regression result showed that economic growth is the sole contributor to the outcome. However, after fsQCA, we found that the relationship of the outcome and economic growth is just a partial picture of the whole causal mechanism. The results of both fsQCA and csQCA illustrated that more than one causal condition conjuncturally were working together to bring about an outcome. Also, more than one set of such conjunctural causes exist which could lead to the improvement in the income of the poor.

We specifically noted that in all causal configuration of the instance of the improvement in the income of the poor, either GOVTEXP92 or GDP92 is present. If we just conducted the regression, it would not capture the presence of GOVTEXP92 in the subsets of the poverty reduction causal mechanism that separately make an impact on the income of the poor. Economic growth is not the sufficient condition that drives poverty reduction, but, government spending together with other conditions also contribute to poverty reduction. This argument aligns with the argument that trickle-down is not enough. Furthermore, those countries whose poverty reduction is achieved by economic growth are clearly separate from those who achieved poverty reduction with public programmes.

The result of fsQCA tended to support the existing theories that human capital and other social factors improve the income of the poorest population of the countries considered. Female labour force participation became part of a sufficient multiple causal condition in some cases for poverty reduction when it was accompanied by government spending or economic growth, despite a few exceptional cases such as Egypt, India, Italy, Pakistan and Sri Lanka. The application of fsQCA enabled us to analyse the medium-N data because we did not have sufficient large-N data for the gendered characteristics behind workforce culture as well as female school attainment behind women’s engagement with work.

Recorded women’s labour force participation rate is just the tip of the iceberg of the actual female participation in the workforce. For example, females in small businesses are often invisible, especially if they are engaged in the agricultural sector or informal sector. They are actually ‘in’ the

labour force rather than out of it. Women using micro-finance would be another example (Berger, 1989). They may not be found from quantitative data as they are not a well-established part of national programmes of data collection and tabulation (Unifem, 2005). However, they could be fuzzified to become part of fsQCA truth tables by collecting qualitative information about the policies that influence women's employment.

Female attainment was not an accompanying condition with government spending. This is probably explained by the shape of U-curve in female participation in the labour force in relation to development. Female labour force participation rates of countries at different stages of development make a U-curve (Goldin 1994). In less-developed countries, female labour force participation rates can decline with initial growth due to the movement of production from the household, family farm, and small business to the wider market, and to a strong income effect. As economies develop, the young female population stays longer in education, labour shifts from intensive agricultural activities to urban economic activities, and there is a rise in earning opportunities in which people may opt out of low earning opportunities. In more developed countries, labour force participation rates increase as employment opportunities grow for both men and women. It continues as developed countries provide more equal opportunities (not necessarily equal payment) for all. Thus, attainment was part of the condition with economic growth for poverty reduction.

7. Conclusion

We compared the results of fuzzy set and crisp set data. The results of the both analysis are identical except one configuration, the configuration of GINI*ILOLFPF92*GDP92, We need to go back to the difference between fsQCA and csQCA. The difference between them was consistency cutoff. The consistency cutoff is always 1 for csQCA while fsQCA allows some degree of inconsistency. This implies that when we allow the consistency cutoff to be lower, some causal pathways could well be hidden due to lack of data appear for consideration.

This paper showed the importance of determining the balance of consistency and coverage outcomes based on various cutoff points for a sensitivity assessment. We argue that the optimal consistency cutoff point helps us optimally determine the configurational multiple causality. The robustness of the results of the truth table algorithm depends on the balance of consistency and coverage.

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Notes

1) Boolean logic includes two kinds of set relations. One, often represented using Venn Diagrams, involves crisp sets of binary variables. X & Y ("X and Y") thus refers to the intersection of sets X and Y. The second kind is fuzzy set relations. Here, the sets X and Y have fuzzy boundaries, or in other words the degree of membership in X is an ordinal index, not a binary variable. The relation X & Y is defined in Boolean fuzzy algebra as the maximum of the two set values. See Bergman, 2008: chs. 1-2.

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Appendix 1:

Variables: names, labels, definitions and sources

Name	Details	Definition	Source
DELTA	The change of income	an improvement in the income share of the poorest 20% quintile in gross domestic product per capita using 1995 US dollars, over 1992 to 2002	WDI
GDPPCRATE	DGP per capital PPP	Domestic Product per capita, adjusted for Purchasing Power Parity, using current international dollars.	WDI
GOVTEXP	Government expenditure as % GDP	Government expenditure as % GDP	OECD(2003)
ILOLFPF	Labor force, % female	The percentage of the workforce that is female.	WDI
GINI93	Gini coefficient	Ratio of economics (income or expenditure) inequality between households, where 1 is maximum inequality and 0 is equality.	Data from Peter Edward
ATTAINF82	Female educational attainment	Ratio of school attainment >age 15, females	Barro, 1980

Appendix 2: The regression result

Table1: Raw Data Summary

Variable	Obs	Mean	Std. Dev.	Min	Max
delta	86	1.22552	0.395381	0.437184	2.744061
gdppcrate1992	165	-1.75426	9.188303	-44.7075	12.84591
govtexp1992	119	26.83279	15.12319	0	100.9869
ilolfpf1992	163	34.48497	11.56771	6.42	54.96
gini93	79	38.13291	10.60257	19.5	63.4
attainf1982	104	4.270452	2.933796	0.066	11.82

Table 2: The regression result

variables	Coefficient (std. err.)
Gdppcrate1992	0.037*
	(0.016)
Govtexp1992	0.000
	(0.005)
Ilolfpf1992	-0.005
	(0.005)
Gini93	-0.003
	(0.005)
Attainf1982	0.019
	(0.021)
constant	1.389
	(0.398)

* = 5% significance or better.

Appendix 3 Raw Data

country	delta	gdppcrate92	govtexp92	ilolfpf92	gini93	attainf82
Bangladesh	1.305333	3.206187	0	39.41	28.3	1.035
Belgium	1.05137	1.115847	49.32376	31.21	25	7.947
Bolivia	0.79275	-0.87038	20.26255	29.05	42	3.804
Brazil	1.132573	-2.03814	29.21272	30.58	63.4	3.062
China	1.581442	12.80898	8.039237	54.96	37.8	3.728
Colombia	0.875423	3.010763	15.19884	28.57	51.3	4.504
Denmark	1.066603	0.299348	40.10101	51.4	24.7	8.601
Dominican Republic	1.634073	6.238371	13.34641	22.12	49	3.566
Egypt	1.264143	2.216335	39.287	19.2	32	1.564
Finland	1.216196	-3.85864	41.60108	47.26	25.6	7.111
Gambia	0.823836	-0.72364	23.60005	44.74	39	0.525
Ghana	0.83518	1.234087	17.79648	47.15	33.9	2.021
Greece	1.48656	-0.03178	28.33867	28.83	32.7	6.351
Hungary	1.411515	-2.85761	56.07836	38.71	22.6	8.719
India	1.473735	3.329006	15.89233	27.4	33.8	1.887
Indonesia	1.247156	5.474233	18.48475	33.74	31.7	3.008
Israel	0.962111	2.040203	48.32692	29.77	35.5	8.999
Italy	1.233384	0.569189	51.53949	30.67	31.2	5.431
Jamaica	0.960805	0.942238	24.25317	45.35	41.1	4.325
Japan	1.089167	0.746978	20.86349	40.59	24.9	8.159
Korea(Rep. of)	2.132312	4.483706	16.59587	36.27	31.6	6.773
Mexico	0.916307	1.737717	14.4422	21.94	50.3	4.397
Netherlands	1.289258	0.984378	50.75117	35.54	31.5	7.987
Nicaragua	1.497441	-2.53502	30.81593	22.92	50.3	3.094
Norway	1.248786	2.72163	42.95217	44.59	25.2	7.744
Pakistan	1.17066	5.038906	24.42491	17.8	31.2	1.048
Panama	1.221661	6.160958	24.96161	25.43	56.8	6.476
Poland	1.742664	2.276408	0	43.62	27.2	8.481
Spain	1.48845	0.696333	34.65195	27.67	58.4	5.471
Sri Lanka	1.582548	3.25123	26.94246	27.53	32.5	5.135
Thailand	1.41291	6.692422	15.02773	53.32	46.2	4.041
Tunisia	1.40207	5.620807	32.05627	20.69	40.2	1.991
Uganda	1.591401	-0.07438	0	48.31	39.2	1.122
United Kingdom	1.169879	-0.04741	42.8158	41.16	36.1	8.249
United States	1.277786	1.886865	23.06397	43.96	45.4	11.82
Yemen	1.548791	4.857788	28.55968	17.4	39.5	0.066

Appendix 4 Fuzzy-set Data

country	deltaf	gdppcrate92f	govtexp92f	ilolfpf92f	gini93f	attainf82f
Zambia	0.51	0.33	0.51	0.51	0.67	0.17
Yemen	0.67	0.67	0.51	0.17	0.51	0
United States	0.51	0.51	0.33	0.83	0.67	1
United Kingdom	0.51	0.51	0.83	0.67	0.33	0.67
Tunisia	0.67	0.83	0.67	0.17	0.51	0
Thailand	0.67	0.83	0	1	0.67	0.17
Sri Lanka	0.67	0.67	0.51	0.33	0.33	0.33
Spain	0.67	0.51	0.67	0.33	0.83	0.33
Poland	0.67	0.51	0.83	0.83	0.17	0.67
Panama	0.51	0.83	0.33	0.17	0.83	0.51
Pakistan	0.51	0.67	0.33	0.17	0.33	0
Norway	0.51	0.51	0.83	0.83	0.17	0.67
Nicaragua	0.67	0.33	0.51	0.17	0.67	0.17
Netherlands	0.51	0.51	1	0.51	0.33	0.67
Mexico	0.33	0.51	0	0.17	0.67	0.33
Korea (Rep. of)	0.83	0.67	0.17	0.51	0.33	0.51
Japan	0.51	0.51	0.33	0.67	0.17	0.67
Jamaica	0.33	0.51	0.33	0.83	0.51	0.33
Italy	0.51	0.51	1	0.33	0.33	0.33
Israel	0.33	0.51	1	0.33	0.33	0.67
Indonesia	0.51	0.67	0.17	0.51	0.33	0.17
India	0.67	0.67	0	0.33	0.33	0
Hungary	0.67	0.33	1	0.67	0	0.67
Greece	0.67	0.51	0.51	0.33	0.33	0.51
Ghana	0.33	0.51	0.17	0.83	0.33	0
Gambia	0.33	0.33	0.33	0.83	0.51	0
Finland	0.51	0.33	0.83	0.83	0.17	0.51
Egypt	0.51	0.51	0.83	0.17	0.33	0
Dominican Republic	0.67	0.83	0	0.17	0.67	0.17
Denmark	0.51	0.51	0.83	1	0.17	0.67
Colombia	0.33	0.67	0	0.33	0.67	0.33
China	0.67	1	0	1	0.51	0.17
Brazil	0.51	0.33	0.51	0.33	1	0.17
Bolivia	0.33	0.33	0.17	0.33	0.51	0.17
Belgium	0.51	0.51	1	0.51	0.17	0.67
Bangladesh	0.51	0.67	0	0.67	0.17	0

Appendix 5 Crisp set Data

country	deltafc	gdppcrate92c	govtexp92c	ilolfpf92c	gini93c	attainf82c
United States	1	1	0	1	1	1
Panama	1	1	0	0	1	1
Belgium	1	1	1	1	0	1
Denmark	1	1	1	1	0	1
Netherlands	1	1	1	1	0	1
Norway	1	1	1	1	0	1
Poland	1	1	1	1	0	1
United Kingdom	1	1	1	1	0	1
Finland	1	0	1	1	0	1
Hungary	1	0	1	1	0	1
Japan	1	1	0	1	0	1
Korea (Rep. of)	1	1	0	1	0	1
Greece	1	1	1	0	0	1
Israel	0	1	1	0	0	1
Zambia	1	0	1	1	1	0
China	1	1	0	1	1	0
Thailand	1	1	0	1	1	0
Jamaica	0	1	0	1	1	0
Gambia	0	0	0	1	1	0
Spain	1	1	1	0	1	0
Tunisia	1	1	1	0	1	0
Yemen	1	1	1	0	1	0
Brazil	1	0	1	0	1	0
Nicaragua	1	0	1	0	1	0
Dominican Republic	1	1	0	0	1	0
Colombia	0	1	0	0	1	0
Mexico	0	1	0	0	1	0
Bolivia	0	0	0	0	1	0
Bangladesh	1	1	0	1	0	0
Indonesia	1	1	0	1	0	0
Ghana	0	1	0	1	0	0
Egypt	1	1	1	0	0	0
Italy	1	1	1	0	0	0
Sri Lanka	1	1	1	0	0	0
India	1	1	0	0	0	0
Pakistan	1	1	0	0	0	0