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Executive Summary

This Master Dissertation is organized in the following structure. *Section one* introduces the theoretical framework of the research and reviews previous literature related to this topic. Since winning medals has become an objective that all countries want to achieve, a lot of empirical research has been devoted to the factors that result in some countries to perform better than others. The present Master Dissertation is in line with this and examines the connection between certain welfare characteristics (in particular: political development, social development, and economic development) and the probability of success in the Olympics of 1984 and 2004. We expect that structural conditions at the macro level still play an important role in determining sporting success at the Olympics. In addition, this section gives a first short impression of these 1984 Los Angeles and 2004 Athens Olympic Games.

The general LISREL-method, used in this Master Dissertation to test the impact of the national welfare characteristics on Olympic medal success, is discussed in *section two*.

The data used to test the research questions are described in detail in *section three*.

Section four presents the LISREL-results. We notice that not all welfare characteristics are of equal importance. First, political development does not exert any influence on Olympic medal success, not in 1984 nor in 2004. Second, social development has a significant effect on Olympic medal success in 1984, but twenty years later, this effect seemed to have disappeared. Third, economic development is a substantive predictor of Olympic success, both in 1984 and in 2004. Consequently, a country's economic development seems to be the most relevant welfare characteristic. In addition, of the control variables, population size seems to be the only consistent determinant.

In *section five*, the significance of the findings is discussed, thereby highlighting weaknesses of the study, and offering suggestions for future research.

Finally, *section six* concludes the Master Dissertation by suggesting that, in order to establish a proper ranking of countries at the Olympic Games, it would be relevant to correct the amount of medals won by each country for economic welfare (for example national income), and for population size.

Keywords: LISREL, Olympic Summer Games, structural equation modeling, welfare characteristics

1. Introduction

Olympic Games have a long history. In 1892, Baron Pierre de Coubertin organized the first modern Games at Athens, trying to revive the spirit of the ancient Olympic Games in Greece. Since then they are probably the largest sporting event around the globe, attracting worldwide interest for a 16-day period every four years. For example at the 2004 Games in Athens, 11099 athletes, 5500 team officials, and 21500 members of the media attended. Athletes from 202 countries participated and around four billion people all over the world followed the Games on television. The International Olympic Committee (IOC), the governing body of the Olympic movement, proclaims the Olympic Games as a celebration of individual as opposed to national athletic achievement. *"The Olympic Games are competitions between athletes in individual or team events and not between countries."* (IOC, 2004, p. 16). As a result, the decisive role of individual efforts, personal features and specific situations of individual athletes is often stressed. However, despite this idealistic statement and the IOC's refusal to recognize country rankings by medals, by-country medal tables are widely published in the media, serving as a source of national pride or disappointment for citizens as well as for governments. Winning medals at Olympic Games has become an objective that all nations strive to accomplish, in order to demonstrate their national power and competency. The Coe Report (1985) came up with three arguments as to why Olympic success resembles such a public good, and why governments and citizens care about it. *First*, success makes people proud of their national identity and vice versa. *Second*, success in the Olympics improves a country's image abroad, e.g. helping to sell national products. *Third*, it boosts participation in sport and recreation, leading to a general improvement in the health of the average citizen.

A glance at Olympic history immediately tells us that not all nations have an equal ability to win Olympic medals. At the Athens Olympics (2004), 124 nations of the 199 did not win a single medal. On the other hand, the top ten winners collectively took home 514 medals, more than 50% of the medals available. Therefore, a natural question that always arises, and which researchers have tried to answer since the post-World War II games, pertains to the identification of the reasons and factors that result in some countries performing better than others by winning more medals. This unequal distribution of Olympic medal numbers might in part be explained by the relative strength of countries in different sports. For example, with a large number of high-quality basketball players, the US should have a higher probability of winning a medal in basketball. Then, a prediction for a national medal total could by predicted by a summation across sports. However, this Master Dissertation takes a different perspective and attempts to predict a nation's Olympic performance by investigating the social welfare characteristics that have a significant influence on a nations' Olympic performance.

Factors affecting performance have been analyzed since the seminal study of the 1952 Olympic Games in Helsinki by Jokl et al. (in: Hoffmann, Ging & Ramasamy, 2002). Early studies from the 1970's (Ball, 1972; Grimes, Kelly & Rubin, 1974; Levine, 1974) showed that population size, income per capita, hosting advantage, and political system have a significant impact on a nation's medal counts. Surprisingly, it was not until the 1990's that this pioneering analysis was consolidated through a burgeoning literature modeling Olympic performance[1] (Baimbridge, 1998). Those empirical studies of the Olympics can be divided into those examining a single tournament (Ball, 1972; Levine, 1974; Grimes et al., 1974; Condon, Golden & Wasil, 1999) or an analysis of

[1] An explanation of this might be that in the 1970's and 1980's the Olympic Games were disrupted by the Cold War (Bian, 2005; Kuper & Sterken, 2001). As known the USA did not participate at the Moscow 1980 Games, while the USSR did not show up at the Los Angeles 1984 Games.

aggregate performance over several Games (Bernard & Busse, 2004; Johnson & Ali, 2000; Seppänen, 1981). Other studies have examined miscellaneous aspects of the Olympics including idealism and political boycotts, whilst another body of literature examined the hypothesis that differences in success in the Summer Games are partially influenced by national religious orientation (Lüschen, 1967). Recently, two studies by Johnson and Ali (2000) and Bernard & Busse (2004) revived the issue of Olympic performance determinants.

In line with this research, and without wanting to deny the impact of individual effort, the present Master Dissertation will examine the connection between certain welfare characteristics and the probability of success in international sports using *Structural Equation Modeling*, a methodology that, to the best of the author's knowledge, has never been used before to model Olympic performance. Moreover, in this Master Dissertation, we wish to test how these relationships change over time, thereby comparing the 1984 Los Angeles games with the 2004 Athens games. We expect that structural conditions at the macro level play an important role in determining success in sports, and consequently suppose that international sports reflect structural positions and resource distributions at the level of the world system, a hypothesis in line with the work of Heinilä (1982), Gruneau (1999), Bale (2003) and Maguire (1999).

Against the above background, this Master Dissertation gives a quantitative analysis of the following topics:

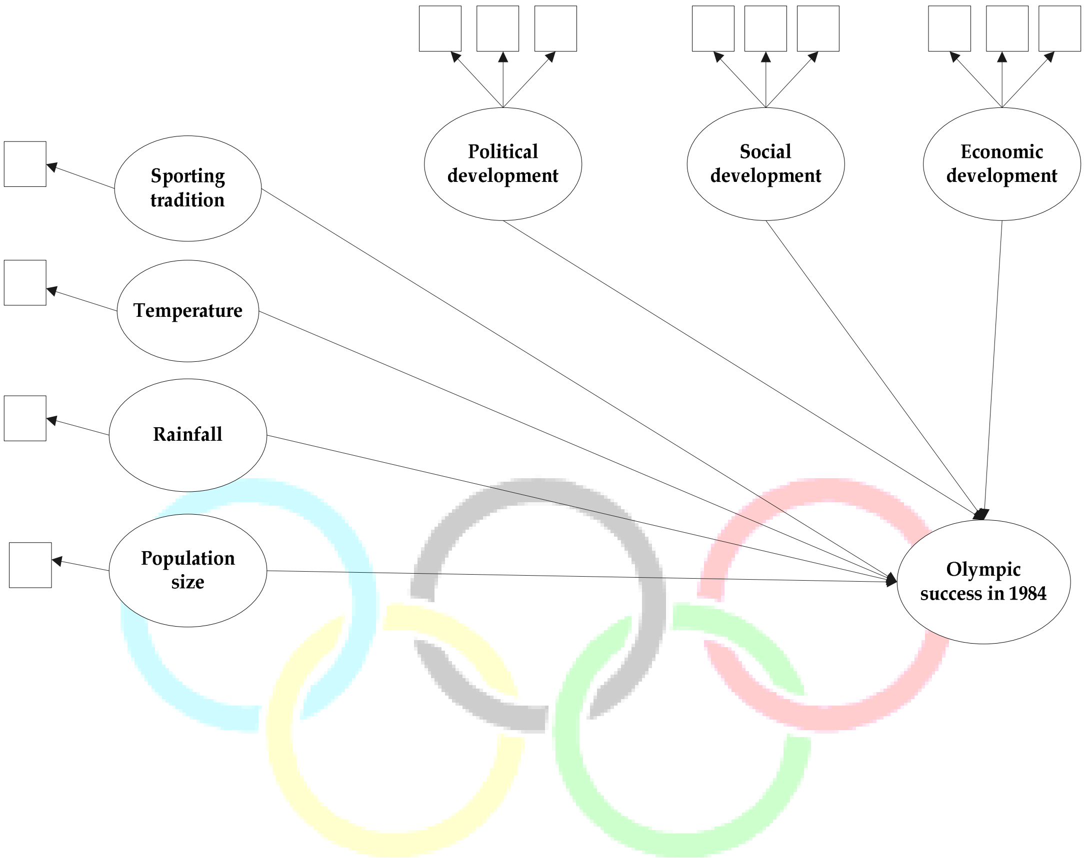
1. To what extent are welfare characteristics predictors of Olympic medal success?

2. If so, what measure of welfare is most relevant in this respect?

3. How do the above mechanisms change over time? In particular, how do the Los Angeles Games (1984) can be compared with the Athens Games (2004) in this respect?

A conceptual model, tested for both 1984 and 2004, can be found in *Figure 1*.

Figure 1 Conceptual model



A warming up…

Before we jump to the methodological part of this Master Dissertation, the following paragraphs give a short introduction to the two editions of the Games that are discussed: the 1984 Los Angeles and 2004 Athens Summer Olympics, thereby highlighting the twenty-year difference in scope and magnitude.

The **1984 Summer Olympic Games**, officially known as the Games of the XXIII Olympiad, were held in 1984 in Los Angeles, California (United States). This city was selected on May 18, 1978 on the 80th IOC session at Athens (Greece) without voting since it was the only bidding city after the financial losses of Montreal two years earlier. In view of the American-led boycott of the 1980 Summer Olympics in Moscow, also in these Olympics a revenge boycott depleted the field in certain sports. In particular, 14 Eastern Bloc countries and the Soviet Union, Cuba and East Germany boycotted these Olympics. Iran and Libya boycotted this edition as well, although for other reasons. This boycott influenced a large number of events that were normally dominated by the absent countries. In total, 6829 athletes (1566 women and 5263 men) from 140 different nations participated at these Games. There were 221 medal events in 23 different sports. Joan Benoit won the inaugural women’s marathon and Connie Carpenter-Phinney the first women’s cycling road race. Carl Lewis won both sprints and the long jump and earned a fourth gold medal in the 4x100 meter relay. Pertti Karppinen won single sculls rowing for the third time. Sebastian Coe became the first repeat winner of the men’s 1500 meter. Archer Neroli Fairhall was the first paraplegic athlete to take part in a medal event, competing in a wheelchair (IOC, 2007).

The **2004 Summer Olympic Games**, officially known as the Games of the XXVIII Olympiad, were celebrated in Athens, Greece, the home of both the ancient Olympics and the first modern Olympics. For the first time ever, a record of 10625 athletes (4329 women and 6296 men) from 201 different National Olympic Committees participated in the Games. The overall medal events tally was 301, in 28 different sports. Popularity in the Games reached new highs as 3.9 billion people had access to the television coverage. Women’s wrestling was included in the program for the first time. Swimmer Michael Phelps won six gold medals and set a single-Games record with eight total medals. Leontien Ziljaard-van Moorsel became the first female cyclist to earn four career gold medals and six total medals, while canoeist

Birgit Fischer became the first athlete in any sport to win two medals in each of five Olympics. Runner Hicham El Guerrouj won both the 1500 meter and the 5000 meter, while on the women’s side Kelly Holmes triumphed in both the 800 meter and the 1500 meter. In team sports, Argentina won the men’s football tournament without giving up a goal, and the US softball team outscored their opponents with a 51-1 victory (IOC, 2007).

2. Methods

A review on the literature regarding Olympic medal success reveals that computing Pearson correlation coefficients and using OLS-regression analysis are the most popular methods for examining relationships between socio-economic and political features of a country and Olympic medal counts. However, using ordinary multiple regression techniques might not be optimal since one must always be aware of the assumptions being made about the data when choosing a particular method of analysis or a specific model. In particular, Ordinary Least Squares regression assumes normality of errors for all observations, an assumption that is often violated. In addition, the estimates of coefficients derived from regression may be subject to omitted variable bias, a problem that arises when there is some unknown variable or variables that cannot be controlled for that affect the dependent variable. Therefore, the size of regression coefficients and the multiple correlation coefficients are typically underestimated because those measurement errors are not taken into account (Bynner, 1994; Hair, Black, Babin, Anderson & Tatham, 2006). This problem may be especially serious in existing cross-national Olympic studies that use secondary international data published by diverse governmental agencies from different countries. In this Master Dissertation, this issue is tackled by using *Structural Equation Modeling* (SEM), an extension of the general linear model of which multiple regression takes part, since it provides the most comprehensive solution to the above 'error-in-variables' problem. Furthermore, using a single indicator to measure welfare characteristics such as social development has a substantive methodological problem since they do not capture the multifaceted nature of these welfare characteristics. One measure, such as primary school enrollment may not adequately represent the social conditions of all countries. Life expectation, tertiary school enrollment, etc. are also important indicators of a country's social development. On the other hand, composite measures have the problem of measurement error that occurs from biased reporting of various indicators of social development transferred to a composite index. Again, LISREL solves this problem, allowing the use of multiple indicators of the conceptual variables and taking measurement error into account (Moaddel, 1994). Other advantages of *Structural Equation Modeling* compared to multiple regression include: more flexible assumptions (particularly allowing interpretation in the face of multicollinearity), the desirability of testing overall models rather than coefficients individually, the ability to test models with multiple dependents, the ability to model mediating variables, the ability to handle difficult data (such as time series with autocorrelated error, non-normal data, incomplete data, etc.) (Hair et al., 2006).

A number of structural equation modeling programs have been developed, for example LISREL (Jöreskog & Sörbom, 2004), AMOS (distributed by SPSS) and EQS. These differ in the range of provided facilities for specifying the model, diagnosing faults in it, and testing the goodness of fit to the data. In this Master Dissertation, we make use of LISREL to demonstrate structural equation modeling in an analysis of panel data on the relationship between certain welfare characteristics and Olympic success. The software is widely documented in the LISREL manuals (Jöreskog & Sörbom, 1996). For a non-technical introduction and/or basis textbooks, see for example Bollen (1989), Diamantopoulos & Siguaw (2000), Hoyle (1995), Loehin (1997).

Before taking a closer look to the data used for the conceptual LISREL-model shown in *Figure 1*, the next paragraph describes the LISREL-model in general.

The lisrel-model: a closer look

During the last decades, there has been a convergence in quantitative methodology and techniques across the social sciences. In particular, structural equation modeling has integrated several research traditions in psychometrics, sociometrics and econometrics. On the one hand, econometricians traditionally focused on simultaneous equation models involving non-recursive relationships among a set of variables that contain negligible measurement error. On the other hand, psychometricians emphasized problems of measurement error and consequently tracked the research areas of factor analysis and reliability analysis. Simultaneously, sociologists' work on path analysis encouraged the arguments that it is possible to attain identification in the presence of both measurement error and simultaneous relationships (Cadwallader, 1987). This synthesis of different approaches is represented by the LISREL-model, a flexible method for dealing with complex models including latent or unmeasured variables.

To test a LISREL-model, two things need to be done. First, the theoretical concepts to which our model relates should be operationalized. Second, the structural relations among the variables should be estimated. In particular, if we want to test a theory to clarify the role of certain welfare characteristics (economic, social and political development) in the attainment of Olympic success, all the concepts need to be operationalized and the structural relationships between them should be estimated. As already touched on, operationalizations might be derived from a single indicator, or from a number of correlated indictors. For example, sporting tradition of a country is measured by a single item (years of IOC-membership). Political development, on the other hand, is measured by a number of indicators (level of democracy, civil liberties, and political rights). Thereby, it is assumed that the separate indicators share something in common which can be measured. To test this assumption, factor analysis is used whereby the resulting factor(s) are treated as measured variables representing the construct(s). The factor loadings in such a *measurement model* express the strength of the relationships between the indicators and the factors underlying them. Factor analysis is a form of data analysis concerned with 'interdependence' whereas other multivariate methods are based on linear relationships and consequently are concerned with the analysis of 'dependence' (for example: multiple regression analysis,

analysis of variance, discriminant analysis). These methods provide estimates of the strength of the relationships between welfare characteristics and Olympic success in terms of a *structural model* (Bynner, 1994). To sum up, the LISREL-model contains two major components: a measurement model and a structural model. The *measurement model* links the observed variables to a set of unobserved or latent variables through a factor analysis model. The causal relationships among these latent variables are then specified in terms of a *structural model*. As input to the simultaneous estimation of parameters of both the measurement model and structural model, a variance-covariance matrix is used, or less common a correlation matrix (Cadwallader, 1987).

In the following paragraph, the LISREL-model is briefly described. For a more in-depth introduction, we refer to the different books cited above.

In *Figure 2*, a simple causal model containing two latent variables and their associated indicator variables is represented. With respect to the *measurement model*, Y1 and Y2 are the observed indicators of the latent variable X2. The coefficients a, b, d and e indicate the accuracy with which the indicators measure the latent variables. The strength of this relationship is equal to the 'validity' of the indicator. The arrows lead from the latent variables to the indicators, so that changes in the latent variables lead to changes in the indicators rather than vice-versa. In many cases the observed variables are not completely determined by the latent variables, and as such have an error term or unique factor associated with them. In *Figure 2*, these unidentified influences are represented by e1, e2, e3 and e4. In this case, they are uncorrelated with each other and with X1, X2 and U. Consequently, the measurement model from *Figure 2* can be expressed in the following equations:

$$Y1=aX1 + e1$$

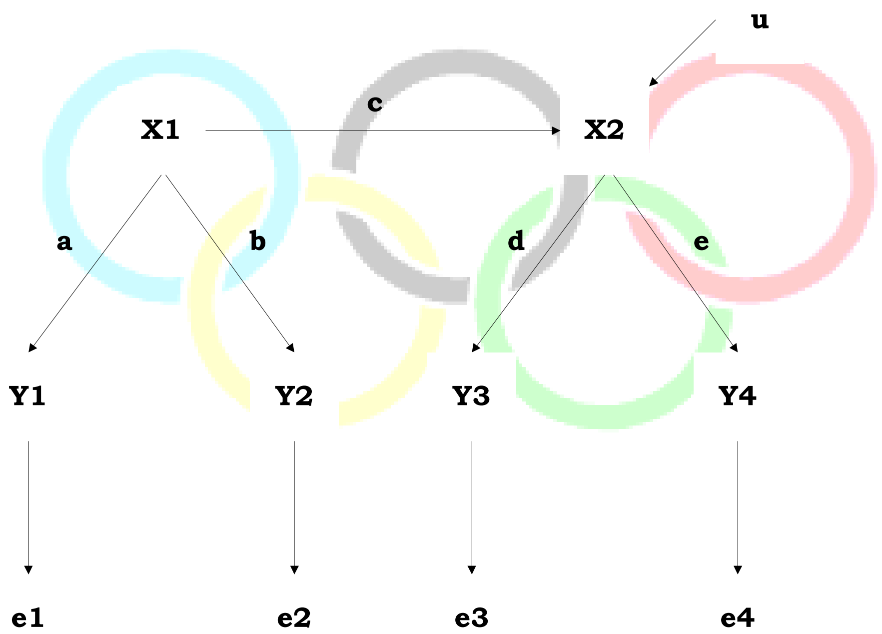
$$Y2=bX1 + e2$$

$$Y3=dX2 + e3$$

$$Y4=eX2 + e4.$$

The structural equation model of the model in *Figure 2* indicates a causal relationship between the latent variables X1 and X2, which implies that a change in X1 produces a change in X2. The extent of this change is represented by the coefficient c. Other unspecified factors, labeled U in this model, also influence X2, but they are assumed to be uncorrelated with X1. To sum up, the LISREL-model both allows for errors in the variables (*measurement model*) as for errors in the equations (*structural model*). In the model in *Figure 2*, the only latent endogenous variable is X2, so that the structural model can be expressed as follows: X2=cX1 + U.

Figure 2 **Lisrel model with latent variables**



Source: (Cadwallader, 1987; Bynner, 1994)

Once our structural equation model is specified, we need to test its goodness-of-fit to the observed data (comprising correlations or covariances), and estimate its structural parameters (factor loadings, path coefficients, variances and covariances). Within this context, the following paragraph discusses some distinctive features of LISREL with respect to the issues of identification, estimation, and goodness-of-fit.

To estimate a model, the parameters must be uniquely determined by the observable data, which implies that the set of simultaneous equations expressing the model must have only one solution (= an 'identified' model). However, models which are just identified yield a perfect fit, which might not be very meaningful and consequently makes the test of the model's fit not really interesting. One might also be confronted by an 'under-identified' model, which occurs when at least one of the structural parameters cannot be identified. The structural equation models most preferred to work with are those that are 'over-identified'. Such an over-identified model occurs when every parameter is identified and at least one parameter is over-identified (which implicates that more than one equation will generate the parameter estimate). An over-identified model has positive degrees of freedom and may not fit that well as a model which is just identified. Imposing restrictions on the over-identified model provides us with a test of our hypotheses, which can be evaluated by using the Chi-square statistic and fit indices. The positive degrees of freedom that are associated with such an over-identified model allow the falsification of the model. When this over-identified model fits well, it can be considered as an adequate fit to the data (SSI, 2007). Imposing restrictions on the model implies constraining certain parameters (factor loadings) in the model to zero or another fixed value, or to make them equal. For example, in *Figure 2Figure 2* only two observed variables have nonzero loadings on each of the factors, consequently restricting certain parameters to zero. The error terms are unrelated as well, fixing another set of parameters. Equality constraints can also be imposed whereby the values of the parameters are constrained to be equal. In all situations, a LISREL model cannot be identified unless the metric or scale of the latent variables has been established because the loadings and variances associated with the latent variables cannot be estimated simultaneously. Consequently, a latent variable should be scaled in terms of standard deviation units of by fixing one loading to a nonzero value. By fixing the variable to one, the latent variable is given the same scale as the observed variable (Hair et al., 2006).

The estimation procedure is iterative such that all the model parameters have to be given initial 'start' values. The program then goes on to estimate the parameters of the models by maximum likelihood methods under the conditions of best fit. As such, the differences between the correlations (or covariances) implied by the parameters and the observed correlations (or covariances) will be minimized. To estimate LISREL models, alternative methods such as generalized least squares and unweighted least squares can be used. However, maximum likelihood is preferred since the estimates are approximately normally distributed and have a comparatively small sampling variance.

For determining goodness-of-fit, the difference between implied and observed variance-covariance matrices can be statistically assessed using a chi-square statistic. The accompanying degrees of freedom for this likelihood-ratio test statistic equals the number of over-identifying restrictions in the model and a comparison is made between the constraints imposed by the model and the unrestricted moments matrix. In a highly constrained model with many parameters set to zero, the value of chi-square relative to degrees of freedom is likely to be large. Releasing constraints on certain parameters reduces the value of chi-square, and as parameters continue to be released, the chi-square drops until one approaching zero can be achieved. However, such 'over-fitting' not only capitalizes on chance, but also defeats the purpose of scientific theorizing which aim is to find the most parsimonious solution. Alongside a reasonable chi-square value relative to degrees of freedom, other indicators such as the goodness-of-fit (ranging from 0 to 1) are used as indicator of fit.

If it is the case that a hypothesized model does not provide a good fit to the data, it can be modified in a number of ways. First, parameters whose estimates are small compared to their standard errors (= non-significant parameters) can be deleted from the model, improving the overall fit by recovering degrees of freedom. Second, parameters can be added to the model. To assess the likely result of relaxing a particular constraint, 'modification indices' (chi-square values) can be used. They estimate how much the overall chi-square will be reduced by releasing the constraint on the parameter and allowing it to be estimated. The greatest improvement in goodness-of-fit is achieved by freeing the parameter with the largest modification index. However, one should be careful that such inductively generated changes make theoretical sense as well. In addition, latent exogenous variables can be left free to correlate, observed variables can become an indicator for more than one latent variable, and the assumption of no correlations between errors can be relaxed. However, here again there should be theoretical reasons of why particular errors are related. Finally, non-recursive relationships can be specified and selected parameters can be constrained to be equal.

As in factor analysis, LISREL assumes continuous and on interval scales measured observed variables, which is the basis on which the product moment correlations or covariances are computed. However, many variables of theoretical interest are not measured in this way. For example, categorical variables are converted into dummy variables and often treated as continuous. Fortunately, LISREL offers a more rigorous approach to include them in the model by computing 'polychoric' and 'polyserial' correlations coefficients[2] alongside product moment correlations coefficients (Hair et al., 2006; Diamantopoulos & Siguaw, 2000).

[2] These are generalizations of tetrachoric and biserial correlations. Tetrachoric *correlations* occur between dichotomous variables assuming an underlying continuous variable. *Biserial correlations* occur where there is one continuous variable correlated with a dichotomous variable.

3. Data

The 'dependent' variables in this analysis are *Olympic success* in 1984 and in 2004. 'Independent' variables are indicators of *political development*, *economic development* and *social development* (in 1984 and 2004). 'Control variables' are *population size* (controlling for general demographic conditions and the availability of talented athletes), *geographical conditions* (controlling for climatic factors), and *sporting tradition* (controlling for the general tradition and degree of institutionalization of top level sports). It is important to note that the availability of comparable international time series data is very limited. For example, it is impossible to obtain good data on the organization of national sport systems or national features of different sports. On the other hand, general data on world social structure, our main area of interest in this Master Dissertation, are readily available from different sources such as the *World Development Indicators*, the *Polity IV* and *Freedom House*. Data on medal counts were available from the *International Olympic Committee*-website. Important to note is that the data is constrained to countries participating in the 1984 as well as in the 2004 Olympics. Moreover, several countries (in particular, Andorra, Antigua & Barbuda, Bermuda, Cayman

Islands, Grenada, Liechtenstein, Monaco, Netherlands Antilles, San Marino, Seychelles and the Virgin Islands) are excluded due to a surplus of unavailable data on welfare characteristics. This yields a total sample size of N = 128.

In the following paragraphs, the operationalization of the different variables is discussed.

Olympic success

With regard to our measure of Olympic success, we use the **number of Olympic medals** a country achieved in 1984 and in 2004, which is available on the IOC website. However, the question arises whether this variable should reflect the winning of gold medals only, or all medals. The choice of gold medals would be based on the argument that winning gold is perceived as the ultimate Olympic success. Also, the ranking of countries in the medal table goes by gold first, irrespective of any other medals. For example in the Sydney 2000 Olympics, the Netherlands came eighth on the ranking while Cuba came ninth, although Cuba won four more medals than the Netherlands. The reason behind this is that the Netherlands won 12 gold medals compared to Cuba’s 11. This implicates that a gold medal is worth more than two silver and three bronze medals. (Cuba won 11 gold, 11 silver and 7 bronze medals; the Netherlands won 12, 9 and 4 respectively). As this might be plausible for the purpose of ranking in the popular media, it is not for the purpose of this paper. However, a straightforward adding up of the medals without weighting is inappropriate for the purpose of measuring this variable. As such, this variable should be a weighted sum of the medals, which implies assigning weights to gold, silver and bronze medals. As mentioned above, the ranking of countries in medal tables considers a gold medal as better than three silver and two bronze medals, which implies the assignment of a heavy weight to gold medals (Moosa & Smith, 2004). For example, Condon et al. (1999) gave gold, silver and bronze medals weights of 0.5, 0.3 and 0.2 respectively, while giving the rest of the five other finalists (the fourth to the eighth) a weight of 0.1. However, according to Moosa & Smith (2004), these weights are not a true reflection of the value of gold medals so that they opt for weights of 0.6, 0.3 and 0.1 respectively, without giving anything to fourth-eighth places. Our choice falls on a weight of 0.5 for gold, 0.3 for silver and 0.1 for bronze, and no weights for fourth-eight places. Moreover, because of the lop-sided distribution of this variable, square roots of the original values have been used.

Political development

Political development is measured by three indicator variables: overall democracy level, civil liberties and political rights. The **democracy level** of countries for both 1984 and 2004 was found in the *Polity IV database* (Marshall & Jaggers, 2005). Democracy is thereby conceived as three essential and interdependent elements. A *first* is the presence of institutions and procedures through which citizens can express preferences about alternative policies and leaders. A *second* is the existence of institutionalized constraints on the exercise of power by the executive. And a *third* is the guarantee of civil liberties to all citizens in their daily lives and in political participation acts (Marshall et al., 2005). Other aspects of plural democracy, such as press freedom, rule of law, etc. are conceived as specific manifestations of these general principles. Important to note is that coded data on civil liberties is not included. The indicator is an additive eleven-point scale (ranging from 0 to 10). The democracy-indicator is derived from codings on the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive. For the specific weights and logic underlying this variable, we refer to Marshall & Jaggers (2005).

Data on civil liberties and political rights for both 1984 and 2004 were found in *Freedom House* data. This 'Freedom in the world' survey provided an annual evaluation of the state of global freedom as experienced by individuals. It measures freedom, defined as the opportunity to act spontaneously in a variety of fields outside the control of the government and other centers of potential domination, according to two categories: political rights and civil liberties. **Political rights** enable people to participate freely in the political process, which includes: the right to vote freely for distinct alternatives in legitimate elections, compete the public office, join political parties, etc. **Civil liberties** allow for the freedoms of expression and belief, associational and organizational rights, rule of law, and personal autonomy without interference from the state. The two indicators range from 1 to 7, with 1 representing the highest and 7 the lowest level of freedom. The rating process is based on a checklist of 10 political rights questions and 15 civil liberties questions. The political rights questions are grouped into three sub-categories: electoral process, political pluralism and participation, and functioning of government. The civil liberties questions are grouped into four sub-categories: freedom of expression and belief, associational and organizational rights, rule of law, and personal autonomy and individual rights (Freedom House, 2007).

Social development

Social development of a country is measured by five indicator variables: life expectancy at birth, primary school enrollment, secondary school enrollment, tertiary school enrollment, and illiteracy rate. Data for both 1984 and 2004 was found in the *World Development Indicators* (World Bank, 2003)[3]. **Life expectancy at birth** is the number of years a newborn infant would life if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. This overall indicator of mortality is an important measure of health status in a country and is frequently used to compare levels of socioeconomic development across countries. The data are from the United Nations Statistics Division's 'Population and Vital Statistics Report' and other releases from national statistical offices (World Bank, 2003, p. 115). Data on **school enrollment** are from the UNESCO Institute for Statistics and are a useful measure of participation in

[3] The most recent available year is 2001. Consequently, data for 2004 in fact refers to the 2001 situation. If data was unavailable for one of the specific years, data for the year most nearby was taken.

education. Gross enrollment ratios are used here, implying the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. It assesses whether an education system has sufficient capacity to meet the needs of universal education. Primary education provides children with basic reading, writing, and mathematics skills along with an elementary understanding of such subjects as history, geography, natural science, social science, art, and music. Secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more subject- or skill-oriented instruction using more specialized teachers. Tertiary education, whether or not leading to an advanced research qualification, normally requires, as a minimum condition of admission, the successful completion of education at the secondary level (World Bank, 2003, p. 83). The **adult rate of illiteracy** is defined as the percentage of people who cannot, with understanding, read and write a short, simple statement about their everyday life. Literacy statistics for most countries cover the population ages 15 and above. The data are based on estimates and projections by the UNESCO Institute for Statistics (World Bank, 2003, p. 91).

Economic development

Economic development of a country is measured by five indicator variables: GDP per capita, employment in agriculture, employment in services, the number of television sets per 1000 people, and the number of motor vehicles per 1000 people. Data for both 1984 and 2004 were found in the *World Development Indicators* (World Bank, 2003)[4]. Gross Domestic Product (GDP) is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output. **GDP per capita** (here in constant 1995 US$) is the Gross Domestic Product divided by midyear population. The data is estimated by World Bank staff based on national accounts data collected by Bank staff during economic missions or reported by national statistical offices to other international organizations such as the Organization for Economic Co-operation and Development (World Bank, 2003, p. 17). To reduce the skew of the distribution, the variable was log transformed (base 10). Data on employment are from the International Labour Organization (ILO)-database.

[4] See previous footnote.

Employment in agriculture (% of total employment) includes hunting, forestry and fishing. **Employment in services** (% of total employment) includes wholesale and retail trade, restaurants and hotels, transport, storage, communications, financing, insurance, real estate, business services, and community, social and personal services (World Bank, 2003, p. 49). The **number of motor vehicles per 1000 people** includes cars, buses and freight vehicles but not two-wheelers. Population figures refer to the midyear population in the year for which data are available. The data is gathered from the International Road Federation's (IRF) electronic files and its annual World Road Statistics (World Bank, 2003, p. 167). Data for the **number of television sets per 1000 people** refer to those in use and come from the International Telecommunication Union (ITU) (World Bank, 2003, p. 301).

Control variables

Three control variables are included in the model: sporting tradition, population size, and geographical conditions.

A first control variable is the **sporting tradition** of a country. A cultural affinity towards sport has a direct effect on the performance of national teams in international sporting events. Countries whose cultures emphasize sport are more likely to generate and support sportsmen and sportswomen. The reasons include greater expected incomes of athletes as well as greater sports participation for non-pecuniary motivations (Tcha & Pershin, 2006). A number of alternative indicators of such a culture could be used, for example television coverage of sporting events, income of sporting stars, revenue in sports industries, etc. However, these parameters are difficult to collect. The proxy that we use to capture this variable is the number of IOC-membership years of a country.

A second control variable is **population size**. Successful sporting performance is generated from a pool of Olympian talent available in a country. Naturally, a country with a larger population would have a larger pool of talented athletes and hence is able to win more medals. This does not mean, however, that the number of medals won increases indefinitely. Consequently, the law of diminishing returns would be expected to step in (Tcha & Pershin, 2006). As a limited number of medals are available for each discipline, there must be a point where additional increases in population have no further impact on medal success (Hoffmann et al., 2002). Because population size precedes both the welfare characteristics and Olympic medals counts in time, data for the year 1980 was included. This data is available from the World Development Indicators (World Bank, 2003). Thereby population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship, except for refugees not permanently settled in the country of asylum, who are generally considered part of the population in their country of origin. The values are midyear estimates for 1980 and are produced by the World Bank's Human Development Network and Development Data Group in consultation with its operational staff and country offices (World Bank, 2003, p. 41). Because of the lop-sided distribution of this variable, the square roots of the original values have been used.

A third control variable is the **geographical conditions** of a country. The initial development of individuals' sporting talent as well as physical and technical sporting ability often takes place in the informal setting of outdoor playing activities. These may be sensitive to the geographical conditions of the country concerned. In short, climatic extremes such as excessively high or low daytime outdoor temperatures, excessive humidity or precipitation should have a negative impact on outdoor sporting activity and therefore on eventual Olympic success (Hoffmann et al., 2002). Two proxies are used for the geographical conditions: annual average daytime Celcius temperature and annual average rainfall (in mm) in the capital city. Both are available from the *World Climate* website (Hoare, 2005).

Table 1 gives a glossary of definitions of the key variables used in the statistical analysis. The intercorrelations, means and standard deviations of the variables in the two different models can be found in *Table 2* and *Table 3* respectively.

Table 1 Glossary of definitions of key variables

Variable	Indicator	Explanation	Dataset
Economic development	loggdp84 / loggdp04	log gdp per capita in 1984 / 2004	World Development Indicators
	serv84 / serv04	employment in services in 1984 / 2004 (% of total)	World Development Indicators
	tele84 / tele04	number of television sets per 1000 people in 1984 / 2004	World Development Indicators
	vehic84 / vehic04	number of motor vehicles per 1000 people in 1984 / 2004	World Development Indicators
	agri84 / agri04	employment in agriculture in 1984 / 2004 (% of total)	World Development Indicators
Social development	life84 / life04	life expectancy at birth in 1984 / 2004	World Development Indicators
	prim84 / prim04	primary school enrollment in 1984 / 2004 (% gross)	World Development Indicators
	sec84 / sec04	secondary school enrollment in 1984 / 2004 (% gross)	World Development Indicators
	tert84 / tert04	tertiary school enrollment in 1984 / 2004 (% gross)	World Development Indicators
	illit84 / illit04	illiteracy rate in 1984 / 2004 (adult total % of people aged 15 and above)	World Development Indicators
Political development	dem84 / dem04	level of democracy in 1984 / 2004	Polity IV
	polri84 / pol04	political rights in 1984 / 2004	Freedom House
	civlib84 / civlib04	civil liberties in 1984 / 2004	Freedom House
Sporting tradition	iocyears	IOC membership years	International Olympic Committee
Temperature	temp	average annual temperature in capital	World Climate
Rainfall	rain	average annual rainfall in capital	World Climate
Population size	sqpop80	square root of population size in 1980	World Development Indicators
Olympic success	sqrtot84 / sqrtot04	square root of weighted total medal count in 1984 / 2004	International Olympic Committee

Table 2 Intercorrelations, means, and standard deviations of the variables in the 1984 model

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	temp	1																	
2	rain	.319**	1																
3	sqrtot84	-.561**	-.149	1															
4	loggdp84	-.584**	-.260**	.690**	1														
5	sqpop80	-.188*	-.097	.481**	.564**	1													
6	iocyears	-.659**	-.139	.604**	.755**	.250**	1												
7	agri84	.430**	.149	-.308**	-.439**	.074	-.457**	1											
8	serv84	-.353**	-.097	.241**	.365**	-.133	.418**	-.942**	1										
9	tele84	-.558**	-.241**	.581**	.619**	.037	.627**	-.585**	.528**	1									
10	vehic84	-.613**	-.204*	.613**	.637**	.040	.657**	-.587**	.553**	.869**	1								
11	life84	-.525**	-.155	.422**	.599**	.056	.598**	-.777**	.720**	.727**	.715**	1							
12	prim84	-.258**	.045	.158	.246**	.094	.245**	-.466**	.433**	.224*	.261**	.547**	1						
13	sec84	-.575**	-.165	.472**	.559**	.015	.641**	-.705**	.655**	.756**	.771**	.854**	.508**	1					
14	tert84	-.574**	-.151	.629**	.697**	.141	.677**	-.558**	.569**	.686**	.766**	.671**	.329**	.717**	1				
15	illit84	.516**	-.034	-.399**	-.475**	-.013	-.561**	.701**	-.673**	-.598**	-.641**	-.862**	-.672**	-.804**	-.632**	1			
16	dem84	-.503**	-.095	.349**	.408**	.020	.564**	-.462**	.454**	.551**	.645**	.619**	.279**	.566**	.532**	-.617**	1		
17	polri84	.489**	.084	-.329**	-.464**	-.036	-.556**	.522**	-.503**	-.539**	-.648**	-.664**	-.370**	-.592**	.585**	.677**	-.921**	1	
18	civlib84	.510**	-.004	-.370**	-.448**	-.022	-.587**	.542**	-.543**	-.566**	-.709**	-.685**	-.331**	-.640**	-.626**	.703**	-.894**	.919**	1
	mean	20.3	1143.6	1.8	23.2	3605.0	55.6	34.0	42.7	149.4	138.2	62.8	93.1	51.5	12.5	31.0	3.8	3.9	4.1
	stddev	6.8	861.3	3.6	2.3	4219.0	25.4	29.7	20.6	173.1	178.7	10.7	24.3	30.6	12.7	26.3	4.4	2.2	2.0
	N	124	124	124	119	124	124	122	122	124	121	124	124	124	123	123	123	123	123

Note: **: p<0.01 level (2-tailed); *: p<0.05 level (2-tailed)

Table 3 Intercorrelations, means, and standard deviations of the variables in the 2004 model

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	temp	1																	
2	rain	.319**	1																
3	sqrtot04	-.524**	-.166	1															
4	loggdp04	-.582**	-.275**	.747**	1														
5	sqpop80	-.188*	-.097	.577**	.590**	1													
6	iocyears	-.659**	-.139	.602**	.726**	.250**	1												
7	agri04	.437**	.199*	-.328**	-.460**	.068	-.453**	1											
8	serv04	-.414**	-.170	.302**	.450**	-.117	.484**	-.960**	1										
9	tele04	-.607**	-.251**	.591**	.691**	.111	.677**	-.614**	.607**	1									
10	vehic04	-.636**	-.209*	.559**	.604**	.026	.678**	-.609**	.601**	.855**	1								
11	life04	-.434**	-.108	.405**	.592**	.097	.569**	-.729**	.700**	.717**	.667**	1							
12	prim04	-.236**	.189*	.111	.126	.032	.191*	-.271**	.253**	.142	.124	.296**	1						
13	sec04	-.594**	-.155	.507**	.595**	.057	.656**	-.736**	.713**	.806**	.754**	.793**	.417**	1					
14	tert04	-.649**	-.169	.597**	.716**	.099	.748**	-.642**	.653**	.797**	.791**	.724**	.227*	.825**	1				
15	illit04	.470**	-.077	-.415**	-.468**	-.004	-.503**	.668**	-.655**	-.612**	-.608**	-.686**	-.418**	-.755**	-.650**	1			
16	dem04	-.441**	.041	.357**	.354**	.049	.567**	-.453**	.472**	.431**	.525**	.485**	.283**	.559**	.539**	-.573**	1		
17	polri04	.420**	-.011	-.352**	-.352**	-.021	-.561**	.443**	-.462**	-.465**	-.575**	-.487**	-.241**	-.573**	-.577**	.535**	-.939**	1	
18	civlib04	.487**	-.041	-.361**	-.317**	.024	-.589**	.461**	-.471**	-.499**	-.617**	-.482**	-.273**	-.611**	-.589**	.545**	-.891**	.946**	1
	mean	20.3	1143.6	2.0	23.7	3605.0	55.6	30.3	48.4	261.6	163.7	65.1	100.2	65.7	22.1	20.2	5.7	3.3	3.2
	stddev	6.8	861.3	3.5	2.3	4219.0	25.4	28.9	21.9	244.2	199.9	13.0	21.0	35.9	21.2	20.1	4.0	2.1	1.7
	N	124	124	124	119	124	124	122	122	124	122	124	124	124	120	118	123	121	121

Note: **: p<0.01 level (2-tailed); *: p<0.05 level (2-tailed)

4. Results

To evaluate the above research questions, structural equation models are used to specify the causal connections between the variables. Using LISREL 8.7 (Jöreskog & Sörbom, 2004), which is based on the maximum-likelihood procedure, the measurement and causal parameters are estimated from the covariance matrices (using listwise deletion). The measures of goodness-of-fit between the models and the observed data are reported as the ratio of chi-square to degrees of freedom (chi^2/df) and the Root Mean Square Error of Approximation (RMSEA). Standardized (and significant) parameter estimates are presented to assess more accurately differences in causal structures between the two models.

Olympic success 1984

The estimated unstandardized (U) and standardized (S) lambda coefficients and their associated T-values (T) for the measurement indicators of the latent constructs (political, social and economic development) of the 1984 model are reported in *Table 4*. Since each variable receives only a single common factor loading, the standardized loadings represent the correlation between each observed variable and the corresponding factor. Moreover, it is possible to ascertain the statistical significance of the estimates by comparing the unstandardized loadings with their standard errors. Consider first the indicators for economic development (metric = loggdp84), the standardized loadings are: .66 for GDP per capita, -.67 for employment in services, -.88 for number of television sets, .93 for number of motor vehicles, -.72 for employment in agriculture. Considering the indicators for social development (metric = life expectation), the standardized loadings are: .96 for life expectation, .49 for primary school enrollment, .89 for secondary school enrollment, .81 for tertiary school enrollment, -.85 for illiteracy rate. Considering the indicators for political development (metric = level of democracy), the standardized loadings are: .94 for level of democracy, -.97 for political rights, and -.95 for civil liberties. Moreover, when the unstandardized loadings are at least twice the size of the standard errors, the estimates are significant at the .05 level. In this case, each of the unconstrained estimates is significant. Furthermore, the variables are well accounted for by the corresponding factors. The R^2 values are, in order of increasing magnitude: .24 for primary school enrollment, .44 for gdp per capita, .45 for employment in services, .52 for employment in agriculture, .65 for tertiary school enrollment, .72 for illiteracy rate, .78 for number of television sets, .80 for secondary school enrollment, .86 for number of vehicles, .89 for level of democracy, .90 for civil liberties, .92 for life expectation, and .94 for political rights.

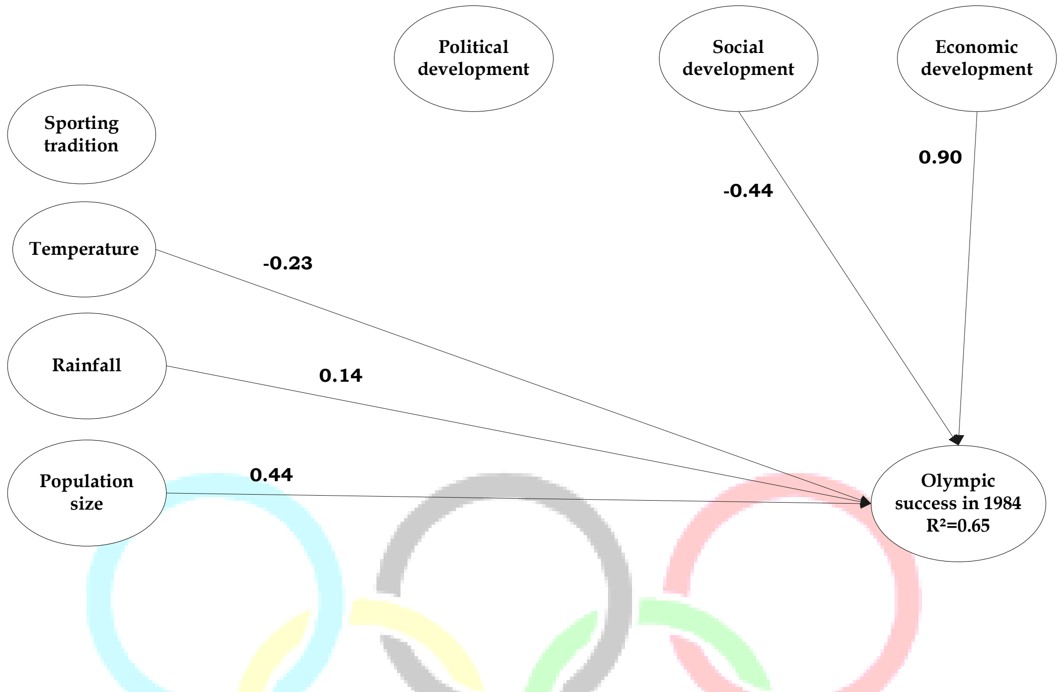
Table 4

Table 4 also contains the correlations between the latent variables (for 1984): political development, social development and economic development. The results indicate a correlation of 31.16 (t=6.40, β=0.76) between political development and social development, a correlation of 4.37 (t=5.19, β=0.70) between political development and economic development, and a correlation of 14.26 (t=5.86, β=0.93) between social development and economic development.

Table 4 Factor loadings for measurement variables + correlations between latent variables (the 1984 model)

		Unstandardized coeffidients	T-values	Standardized coefficients
Economic development	Loggdp84	1.00		0.66
	Serv84	-9.05	-6.84	-0.67
	Tele84	101.03	-8.70	-0.88
	Vehic84	109.93	8.90	0.93
	Agri84	-14.07	-7.30	-0.72
Social development	Life84	1.00		0.96
	Prim84	1.18	6.20	0.49
	Sec84	-2.68	-18.08	0.89
	Tert84	1.01	11.64	0.81
	Illit84	-2.19	-15.60	-0.85
Political development	Dem84	1.00		0.94
	Polri84	-0.52	-24.89	-0.97
	Civlib84	-0.45	-22.71	-0.95
Correlations	political development & social development	31.16	6.40	0.76
	political development & economic development	4.37	5.19	0.70
	social development & economic development	14.26	5.86	0.93

Figure 3 Standardized estimates of the hypothesized structural model predicting Olympic success in 1984 (significant paths only)



Note: chi^2=187.77 (df=107); RMSEA=0.078

With respect to our initial structural model for 1984, the Full Information Maximum Likelihood Chi^2-statistic was 681.15 with 112 degrees of freedom, which is large enough to reject the null hypothesis that the model is a good fit to the data. In addition, the Root Mean Square Error of Approximation (RMSEA) was 0.20, definitely too high to indicate a good fit. Based on the modification indices, the overall model fit could be improved by means of adding (theoretically plausible) error covariances between several variables. Taking some of these advices into account, the estimation results of the 1984 model reported in *Figure 3* show that the adapted model gives a better fit (chi^2/df = 187.77/107; RMSEA = 0.078), although still not convincing.

As shown in *Figure 3*, both the social development and the economic development of a country showed significant effects on Olympic medal success in 1984 (β=-0.44 and 0.90, respectively). Furthermore, the effect of the two control variables relating to geographical conditions, annual average temperature and annual average annual rainfall, were significant (β=-0.23 and 0.14, respectively). The control variable population size exerts a significant effect on Olympic medal success in 1984 as well (β=0.44). The effects of both the political development and the sporting tradition of a country were not significant.

Olympic success 2004

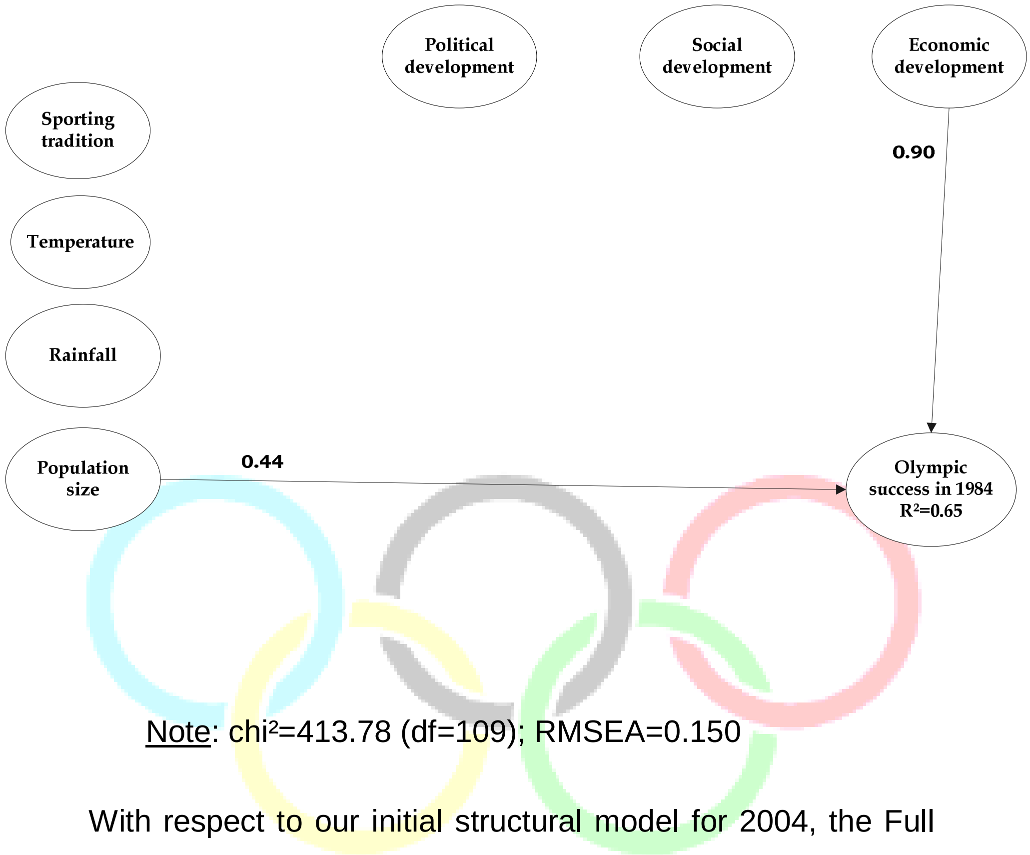
The estimated unstandardized (U) and standardized (S) lambda coefficients and their associated T-values (T) for the measurement indicators of the latent constructs (political, social and economic development) of the 2004 model are reported in *Table 5*. Again, each variable receives only a single common factor loading so that the standardized loadings represent the correlation between each observed variable and the corresponding factor. Consider first the indicators for economic development (metric = loggdp84), the standardized loadings are: .69 for GDP per capita, .71 for employment in services, -.93 for number of television sets, .89 for number of motor vehicles, -.72 for employment in agriculture. Considering the indicators for social development (metric = life expectation), the standardized loadings are: .82 for life expectation, -.27 for primary school enrollment, .94 for secondary school enrollment, -.89 for tertiary school enrollment, -.78 for illiteracy rate. Considering the indicators for political development (metric = level of democracy), the standardized loadings are: .90 for level of democracy, -.95 for political rights, and -.99 for civil liberties. Again, each of the unconstrained estimates is significant. Furthermore, the variables are well accounted for by the corresponding factors, except for primary school enrollment. The R^2 values are, in order of increasing magnitude: .07 for primary school enrollment, .48 for GDP per capita, .51 for employment in services, .52 for employment in agriculture, .60 for illiteracy rate, .68 for life expectation, .79 for tertiary school enrollment, .79 for the number of vehicles, .81 for level of democracy, .86 for number of television sets, .87 for secondary school enrollment, .91 for political rights, .99 for civil liberties.

Table 5 also contains the correlations between the latent variables (for 2004) political development, social development and economic development. The results indicate a correlation of 24.86 (*t*=5.35, *β*=0.66) between political development and social development, a correlation of 3.38 (*t*=4.71, *β*=0.59) between political development and economic development, and a correlation of 16.21 (*t*=5.70, *β*=0.95) between social development and economic development.

Table 5 Factor loadings for measurement variables + correlations between latent variables (the 2004 model)

		Unstandardized coeffidients	T-values	Standardized coefficients
Economic development	Loggdp04	1.00		0.69
	Serv04	9.72	7.42	0.71
	Tele04	-141.52	-9.44	-0.93
	Vehic04	111.07	9.12	0.89
	Agri04	-13.01	-7.55	-0.72
Social development	Life04	1.00		0.82
	Prim04	-0.51	-2.93	-0.27
	Sec04	3.12	13.71	0.94
	Tert04	-1.00	-12.60	-0.89
	Illit04	-1.46	-10.24	-0.78
Political development	Dem04	1.00		0.90
	Polri04	-0.56	-29.12	-0.95
	Civlib04	-0.48	-17.05	-0.99
Correlations	Political development & social development	24.86	5.35	0.66
	Political development & economic development	3.38	4.71	0.59
	Social development & economic development	16.21	5.70	0.95

Figure 4 Standardized estimates of the hypothesized structural model predicting Olympic success in 2004 (significant paths only)



Note: chi²=413.78 (df=109); RMSEA=0.150

With respect to our initial structural model for 2004, the Full Information Maximum Likelihood Chi²-statistic was 656.7 with 112 degrees of freedom, which is large enough to reject the null hypothesis that the model is a good fit to the data. In addition, the Root Mean Square Error of Approximation (RMSEA) was 0.20, definitely too high to indicate a good fit. Based on the modification indices, the overall model fit could be improved by means of adding (theoretically plausible) error covariances between several variables. Taking some of these advices into account, the estimation results of the 2004 model reported in *Figure 4* show that the model still does not fit the data well (chi^2/df = 413.78/109; RMSEA = 0.150).

As shown in *Figure 4*, and comparable to the 1984 model, the effect of both the political development and the sporting tradition of a country are not significant. Moreover, and unlike the 1984 model, in 2004, annual average temperature, annual average rainfall and social development do not longer exert any significant influence on Olympic medal success. The only significant effects on Olympic medal success in 2004 come from a country's economic development, and population size (β=0.58 and 0.49, respectively).

In the following paragraph, an answer is formulated to the three research questions posed in the introduction part of this Master Dissertation.

1. To what extent are welfare characteristics predictors of Olympic medal success?

Three different welfare characteristics of a country were included in the model: political development, social development and economic development. Only a country's social and economic development has significant effects on Olympic success.

2. If so, what measure of welfare is most relevant in this respect?

Not all of the welfare characteristics seem to be equally important. First, political development does not exert any significant influence on Olympic medal success, not in 1984 nor in 2004. Second, social development of a country has a significant effect on Olympic medal success, but only in 1984. Twenty years later, this effect disappears. Third, economic development is a predictor of Olympic success, both in 1984 and in 2004. Consequently, a country's economic development seems to be the most relevant welfare characteristic, influencing Olympic medal success both in 1984 and 2004.

3. How do the above mechanisms change over time? In particular, how do the Los Angeles games (1984) can be compared with the Athens games (2004) in this respect?

As already mentioned in the answers on the previous two questions, political development has no effect on Olympic success, not in 1984 and not in 2004. Social development, however, influences Olympic medal success in 1984 but not in 2004. Economic development at last has a significant effect on Olympic success both in 1984 and in 2004.

5. Discussion

Before we give a deeper insight into the main conclusions of this Master Dissertation, we highlight some major shortcomings and future research opportunities.

First, a major technical problem is that the dependent variable in the statistical model is either zero, for a large set of countries that participated in the Olympic Games of 1984 and 2004 but did not win any medals, or positive. Therefore, maybe an estimation procedure for models with Poisson dependent variables should be applied, since the Poisson distribution is especially adequate for the description of the occurrence of rare events (such as winning an Olympic medal). In this Master Dissertation, we have taken the square roots of the original values to deal with the lop-sided distribution. However, this might not be enough. Another solution to deal with highly non-normal variables is the use of robust maximum likelihood and Satorra-Bentler chi-square correction for non-normality. However, in our case, the sample size might be too small to estimate the asymptotic covariance matrices accurately.

A *second* problem is the bad fit of our model, both for the 1984 data as for the 2004 data. Although we tried to improve the model fit, which is a reasonable thing to do, it should not be viewed as the most worthwhile objective. As Hayduk (1990, p. 196) states: *"If one adopts the philosophy that structural equation models are supposed to be prods to sluggish imaginations, sparks that ignite insight, keys that unlock advancement, or hammers that forge progress from burning issues, we will have to do better than merely searching through the list of potentially-freeable coefficients, no matter how diligently and with how much technical sophistication we conduct the search."* It is important not to deny the context surrounding the model. In this case, maybe the inclusion of other interesting variables is necessary for a good fit. A possible determinant included in other research might be the home advantage of countries, since each home country is allowed to participate in all events. Moreover, the crowd of home spectators will support the performing home athletes. In addition, media attention puts some pressure on the home athletes. According to Kuper & Sterken (2001), it seems that at the recent versions of the Olympic Games, countries that will host the next version perform better. For example, Korea doubled its medals at the 1984 medals before hosting the 1988 Olympics. Also, Greece doubled its normal medals at the Sydney 2000 Games. Another often mentioned determinant of Olympic success is religion

(Lüschen, 1967; Seppänen, 1981). In the past, protestant countries were more successful because of their performance-oriented philosophy. Also, Muslim-countries were less successful because of the role of women in sports (Sfeir, 1985).

A major research opportunity is the use of a panel study, since our data has a clear panel structure, namely data on two different occasions for all countries. In this Master Dissertation, we have not made use of this longitudinal nature, but did a separate analysis at each occasion. By doing a real panel analysis, we could estimate the effect of Olympic success in 1984 on the Olympic success in 2004. However, we tried to estimate this model, but unfortunately it did not converge. Consequently, to adequately make use of the longitudinal data structure, a closer look should be taken towards the methodological problems with respect to connecting two second-order factor models. An additional research opportunity is applying the same models (with the use of multiple indicators for the three welfare indicators) to more different Olympic years, or to apply them to the Winter Olympics.

6. Conclusion

This Master Dissertation was the first to use structural equation modeling in predicting success at Olympic Summer Games. The analysis, with multiple indicators for the three different welfare characteristics, confirms the continuing relevance of structural equalities at the world level for international sport. Even though previous research revealed a decrease in the effect of structural factors, especially since the 1980s, they still play a major role in determining success probabilities. Of particular importance is the level of economic development and population size, a measure of the number of potential athletes. The level of social development, along with climatic conditions, also had a substantial influence on success in 1984 but disappeared for the year 2004. This is probably due to the general process of democratization that went on since the early 1980’s and which narrowed the ‘social gap’ between countries. This implies for example that in 2004, in comparison to 1984, more countries can rely on a well-established educational system which systematically trains young people and have a large number of highly skilled personnel which can take on responsibility in sport. Moreover, since more and more countries have highly specialized training facilities (e.g.

indoor high altitude training) as well as more travel opportunities to train, the role of climatic conditions in predicting sporting success has disappeared as well.

Contrary to our hypotheses, the sporting tradition and the political development of a country are no fundamental determinants of Olympic success. In countries where sport is institutionalized as a societal activity and where performance is accepted and appreciated by the public, it was expected that more resources would be used for training, and athletes would be stimulated more. However, the sporting tradition of a country, measured by the years of IOC membership, exerts no influence on Olympic medal counts. Also, the hypothesized effect of a country's political development on Olympic success is not confirmed. Maybe this is due to the fact that political development was measured by means of three continuous indicators. Existing research confirming the link between political development and Olympic success, on the other hand, generally includes a dummy variable, thereby comparing former socialist countries to the rest. There is large evidence that communist countries perform better because economies with central planning allow more specialization and more national resources were used for training and supporting athletes than in market-based economies. Moreover, in those countries, sport is considered as an instrument to increase the national standing. In addition, it is suspected that socialist athletes used more drugs than others, although this is not proven. However, since the breakdown of the East-European communist systems, things have changed. In the last decade, also market-based economies have further specialized in sports. Nevertheless, according to Kuper & Sterken (2001), former socialist countries are still able to perform at a high standard despite the liberalization process (see for example Bulgaria, Romania, Russia, Poland).

In 2004, a country's economic development, along with its population size, are still major determinants of the performance at Olympic Games. These apparent relationships show that, in order to establish a proper ranking of countries at the Olympic Games, it could be relevant to correct the amount of medals won by each country for economic welfare (for example national income), and for population size. These relative rankings are considered in the next two paragraphs.

A first fundamental determinant of medal success, both in 1984 and in 2004, is population size. This is not so surprising, since a larger population increases the group of potential athletes, but also increases the possibilities to organize training and competitions. This is related to the fact that large countries have a more ‘leveled out’ competition, as a result of which athletes can train together and compete with each other. However, there is a large debate on the impact of a larger population on the performance of athletes. A country like India, for example, has a large population but relatively low success rate at the Games. Bangladesh is the country with the largest population, but has never won a medal. Another issue in this respect is that countries with many talented athletes are not allowed to send them all since for most events there are participation limits. In conclusion, the relationship between population size and Olympic success is a rather complicated one (Kuper & Sterken, 2001).

When success is expressed as the number of medals per head of the population, we get the following picture for Athens 2004 (see *Table 6*). The Bahamas, with only two medals (1 gold and 1 bronze) and only 300 000 inhabitants, is relatively the most successful country. Both medals were obtained in athletics by: Debbie Ferguson on the 200m and by Tonique Williams-Darling on the 400m. Australia holds the second position, followed by Cuba. Belgium ends at the bottom of the table (43rd place). Large countries such as the United States of America (40th place) and China (70th place) are no longer among the world top with this relative prediction of success (De Bosscher, De Knop & Heyndels, 2006).

Table 6 Number of medals per million inhabitants for Athens 2004: 15 'best' countries

Position	Country	Medals	Per million inhabitants	Position	Country	Medals	Per million inhabitants
1	Bahamas	2	6.67	9	Hungary	17	1.69
2	Australia	59	2.96	10	Bulgaria	12	1.60
3	Cuba	27	2.39	11	Denmark	8	1.48
4	Estonia	3	2.24	12	Belarus	15	1.45
5	Slovenia	4	1.99	13	The Netherlands	22	1.35
6	Jamaica	5	1.84	14	Greece	14	1.31
7	New-Zealand	7	1.75	15	Norway	6	1.31
8	Letland	4	1.73				

Note: adapted from De Bosscher, De Knop & Heyndels 2006 (2006, p. 222).

A second major determinant of Olympic success, both in 1984 and in 2004, is the economic development of a country. First, economic development allows countries to invest more in sport and elite-level sport in particular. There are more training facilities, systems to identify talented youth, better training methods, etc. Second, individuals growing up in poorer countries often cannot afford themselves to buy special equipment for certain sports. Maybe this is one of the reasons that Kenya and Ethiopia have so many good long distance runners. They need hardly any material, one can even run barefoot. Third, keeping the high correlation between economic and social development in mind (see *Table 4* and *5*), the standard of living is higher in richer countries, the mortality rate is lower, and richer countries score better on the health index. In addition, elite level sport often coincides with injuries, of which poorer countries have more difficulties to deal with (De Bosscher et al., 2006). *Table 7* looks at the success rate in the Athens Olympics per Gross Domestic Product per capita. One can notice the fact that China, at the bottom with respect to success per citizen, acts well in this table, as does Russia. Ethiopia and Kenia, with seven medals each, also score well. Per head of the population, their richness is more or less 13000 times smaller than that of the USA. Still, the USA is in the top ten. Three countries appear both in the table relative to population size as in the table relative to GDP per capita: Cuba, Australia and Belarus. Maybe these countries should be perceived as the successful ones (De Bosscher, De Knop & Heyndels, 2006)?

Table 7 Number of medals per GDP per capita for Athens 2004: 15 'best' countries

Position	Country	Medals	Per GDP per capita	Position	Country	Medals	Per GDP per capita
1	China	63	12.60	9	USA	103	2.72
2	Russia	92	10.34	10	Romania	19	2.71
3	Ethiopia	7	10.00	11	Belarus	15	2.46
4	Cuba	27	9.31	12	Nigeria	2	2.22
5	Kenya	7	7.00	13	Australia	59	2.03
6	Ukraine	23	4.26	14	Germany	48	1.74
7	Korea DPR (North)	5	3.85	15	Korea (South)	30	1.69
8	Uzbekistan	5	2.94				

Note: adapted from: De Bosscher, De Knop & Heyndels (2006, p. 222).

In conclusion, rich and big countries are still considerably advantaged when it comes to international (Olympic) sports. Based on the results of this Master Dissertation, using different indicators for the three welfare characteristics, and on results from previous research, we can state that: *"the ideological claim referring to a global 'Olympic family' of international sport associations must be questioned. Even if it shares some values, there are still substantial and relevant* *inequalities within the 'family group'."* (Stamm & Lamprecht, 2001).

Annexes: lisrel syntax

The prelis-file is constructed and adapted from a spss-file.

Measurement model 1984

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 MO NX=13 NK=3 TD=SY
 LK
 poldev84 socdev84 ecodev84
 FR LX(1,3) LX(2,3) LX(3,3) LX(4,3) LX(6,2) LX(7,2) LX(8,2)
LX(9,2) LX(11,1)
 FR LX(12,1) TD(2,1) TD(5,4) TD(8,5) TD(9,6) TD(13,8)
 VA 1 LX(5,2)
 VA 1 LX(10,1)
 VA 1 LX(13,3)
 PD
 OU MI

Number of Input Variables 18
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                           Number of X - Variables   13
                           Number of ETA - Variables  0
                           Number of KSI - Variables  3
                           Number of Observations   124

 TI

         Covariance Matrix
```

	AGRI84	SERV84	TELE84	VEHIC84	LIFE84	PRIM84
AGRI84	876.56					
SERV84	-571.69	420.95				
TELE84	-2963.93	1844.73	29957.23			
VEHIC84	-3097.24	2004.06	26888.88	32205.93		
LIFE84	-245.98	157.82	1348.58	1373.97	115.01	
PRIM84	-331.30	214.57	942.81	1134.03	142.64	591.87
SEC84	-635.65	408.02	4009.03	4243.40	280.47	378.80
TERT84	-208.07	146.14	1518.60	1717.45	91.33	103.18
ILLIT84	541.33	-361.40	-2678.35	-2965.31	-242.06	-427.89
DEM84	-59.17	40.27	416.93	503.47	29.06	30.17
POLRI84	33.69	-22.59	-205.76	-253.53	-15.73	-20.12

```
 CIVLIB84      31.55      -21.98     -192.96     -244.27      -14.51
-16.17
 LOGGDP84     -29.55       16.91      246.87      252.59       14.80
13.54

         Covariance Matrix

               SEC84      TERT84     ILLIT84       DEM84     POLRI84
CIVLIB84
            --------    --------    --------    --------    --------
--------
    SEC84     937.87
   TERT84     281.34      163.13
  ILLIT84    -645.34     -210.17      689.44
    DEM84      75.56       29.07      -70.70       19.06
  POLRI84     -39.85      -16.16       39.03       -8.85        4.85
 CIVLIB84     -38.47      -15.58       36.31       -7.68        3.98
3.88
 LOGGDP84      39.59       20.53      -27.91        3.99       -2.28
-1.98

         Covariance Matrix

            LOGGDP84
            --------
 LOGGDP84       5.31
```

Measurement model 2004

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LX(9,1) LX(11,2)
 FR LX(12,2) TD(2,1) TD(7,1) TD(7,6) TD(8,1) TD(9,6) TD(10,9)
TD(11,10) TD(13,8)
 VA 1 LX(5,1)
 VA 1 LX(10,2)
 VA 1 LX(13,3)
 PD
 OU MI

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                           Number of ETA - Variables  0
                           Number of KSI - Variables  3
                           Number of Observations   124
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TI

Covariance Matrix

	AGRI04	SERV04	TELE04	VEHIC04	LIFE04	PRIM04
AGRI04	830.31					
SERV04	-605.19	478.55				
TELE04	-4283.36	3212.52	59616.25			
VEHIC04	-3457.65	2602.68	41551.99	39657.35		
LIFE04	-273.07	198.97	2279.65	1715.48	169.77	
PRIM04	-159.98	113.60	728.12	520.57	81.00	440.67
SEC04	-758.18	557.53	7057.00	5379.39	370.58	313.63
TERT04	-388.57	303.17	4182.57	3380.61	198.31	96.87
ILLIT04	401.02	-298.44	-3066.02	-2449.47	-184.13	-198.14
DEM04	-52.72	41.65	422.80	413.65	25.47	24.19
POLRI04	27.21	-21.49	-240.20	-238.17	-13.37	-10.64
CIVLIB04	23.41	-18.12	-213.14	-211.63	-10.96	-9.99
LOGGDP04	-29.59	21.85	391.15	278.76	17.90	6.03

Covariance Matrix

	SEC04	TERT04	ILLIT04	DEM04	POLRI04	CIVLIB04
SEC04	1286.64					
TERT04	634.10	458.55				
ILLIT04	-554.49	-282.46	417.50			
DEM04	80.29	45.31	-47.53	16.16		
POLRI04	-42.91	-25.47	22.94	-7.89	4.37	
CIVLIB04	-37.95	-21.69	19.53	-6.21	3.43	3.01
LOGGDP04	49.42	35.54	-21.46	3.20	-1.66	-1.24

Covariance Matrix

	LOGGDP04
LOGGDP04	5.45

Structural model 1984

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 LE
 sccs
 LK
 poldev socdev ecodev popsize rainfall temperat sporttra
 FI TE(1,1) TD(1,1) TD(2,2) TD(3,3) TD(4,4)
 FR LX(6,1) LX(7,1) LX(9,2) LX(10,2) LX(11,2) LX(12,2) LX(14,3)
LX(15,3) LX(16,3)
 FR LX(17,3) GA(1,2) GA(1,3) GA(1,4) GA(1,5) GA(1,6) TD(11,1)
TD(12,9) TD(13,1)
 FR TD(13,11) TD(14,11) TD(15,14) TD(17,8)
 VA 1 LY(1,1)
 VA 1 LX(1,7)
 VA 1 LX(2,6)
 VA 1 LX(3,5)
 VA 1 LX(4,4)
 VA 1 LX(5,1)
 VA 1 LX(8,2)
 VA 1 LX(13,3)
 PD
 OU MI

TI

                        Number of Input Variables 18
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                        Number of X - Variables   17
                        Number of ETA - Variables  1
                        Number of KSI - Variables  7
                        Number of Observations   124

 TI
```

Covariance Matrix

	SQRTOT84	IOCYEARS	TEMP	RAIN	SQPOP80	DEM84
SQRTOT84	13.22					
IOCYEARS	55.70	642.66				
TEMP	-13.86	-113.53	46.21			
RAIN	-465.65	-3035.89	1866.60	741912.46		
SQPOP80	7376.62	26733.73	-5391.30	-353338.63	17799768.77	
DEM84	5.53	62.14	-14.69	-351.66	332.44	18.99
POLRI84	-2.60	-31.15	7.06	179.91	-337.09	-8.69
CIVLIB84	-2.57	-29.37	6.60	34.15	-152.02	-7.66
LIFE84	16.47	162.65	-38.26	-1431.53	2533.09	28.94

PRIM84	14.00	151.27	-42.75	944.91	9632.26	29.88
SEC84	52.56	497.34	-119.77	-4353.35	1897.39	75.46
TERT84	29.13	218.76	-49.80	-1710.82	7752.07	28.91
ILLIT84	-37.90	-372.39	91.73	-754.99	-1471.26	-70.38
LOGGDP84	5.66	43.01	-8.97	-470.33	5184.43	4.15
AGRI84	-33.31	-339.56	86.26	3700.67	9349.42	-58.86
SERV84	17.82	212.72	-48.47	-1597.40	-11558.83	40.14
TELE84	365.34	2750.56	-656.11	-35932.45	27183.72	415.90
VEHIC84	391.49	2990.89	-745.14	-34400.45	27995.75	503.35

Covariance Matrix

	POLRI84	CIVLIB84	LIFE84	PRIM84	SEC84	TERT84
POLRI84	4.70					
CIVLIB84	3.89	3.81				
LIFE84	-15.56	-14.43	115.01			
PRIM84	-19.86	-15.61	142.64	591.87		
SEC84	-39.60	-38.58	280.47	378.80	937.87	
TERT84	-16.15	-15.43	91.30	102.58	279.92	162.12
ILLIT84	38.31	35.31	-242.34	-427.14	-645.76	-210.42
LOGGDP84	-2.37	-2.04	15.13	14.31	39.11	20.01
AGRI84	33.13	31.33	-246.13	-329.84	-636.45	-208.61
SERV84	-22.32	-21.82	157.57	213.76	408.44	146.50
TELE84	-205.69	-197.85	1348.58	942.81	4009.03	1512.34
VEHIC84	-251.99	-247.37	1374.84	1126.93	4243.23	1710.69

Covariance Matrix

	ILLIT84	LOGGDP84	AGRI84	SERV84	TELE84	VEHIC84
ILLIT84	689.47					
LOGGDP84	-29.34	5.08				
AGRI84	540.95	-30.37	876.62			
SERV84	-360.22	17.40	-570.65	419.64		
TELE84	-2689.25	256.23	-2975.12	1842.42	29957.23	

VEHIC84	-2961.27	253.30	-3103.28	2010.15	26941.38	32270.50

Structural model 2004

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 success
 LK
 sporttra temp rainfall popsize poldev socdev ecodev
 FI TE(1,1) TD(14,14) TD(15,15) TD(16,16) TD(17,17)
 FR LX(2,5) LX(3,5) LX(5,6) LX(6,6) LX(7,6) LX(8,6) LX(10,7)
LX(11,7) LX(12,7)
 FR LX(13,7) GA(1,4) GA(1,7) TD(3,2) TD(6,1) TD(7,1) TD(8,5)
TD(9,1) TD(9,6)
 FR TD(11,10) TD(13,1)
 VA 3.45 LY(1,1)
 VA 1 LX(1,5)
 VA 1 LX(4,6)
 VA 1 LX(9,7)
 VA 1 LX(14,4)
 VA 1 LX(15,3)
 VA 1 LX(16,2)
 VA 1 LX(17,1)
 PD
 OU MI

TI

                           Number of Input Variables 18
                           Number of Y - Variables    1
                           Number of X - Variables   17
                           Number of ETA - Variables  1
                           Number of KSI - Variables  7
                           Number of Observations   124

 TI

         Covariance Matrix
```

	SQRTOT04	DEM04	POLRI04	CIVLIB04	LIFE04	PRIM04
SQRTOT04	11.93					
DEM04	4.91	16.11				
POLRI04	-2.50	-7.76	4.29			
CIVLIB04	-2.15	-6.13	3.38	2.94		
LIFE04	18.22	25.35	-13.21	-10.50	169.77	

PRIM04	8.04	23.89	-10.41	-8.19	81.00	440.67
SEC04	62.85	80.29	-42.12	-36.25	370.58	313.63
TERT04	44.29	45.39	-25.42	-21.52	198.83	97.11
ILLIT04	-29.21	-46.88	21.86	18.40	-181.92	-196.65
LOGGDP04	5.77	3.40	-1.75	-1.35	18.32	7.62
AGRI04	-32.14	-52.32	27.15	22.17	-272.75	-160.51
SERV04	22.44	41.25	-21.39	-17.06	198.70	113.81
TELE04	498.82	422.10	-242.04	-212.31	2279.65	728.12
VEHIC04	384.53	412.53	-238.23	-210.37	1715.70	518.82
SQPOP80	8411.67	806.34	-111.05	161.70	5337.77	2822.49
RAIN	-493.57	144.11	5.58	-33.31	-1210.59	3410.11
TEMP	-12.31	-11.88	5.86	5.70	-38.48	-33.67
IOCYEARS	52.75	57.56	-29.19	-25.76	188.09	101.54

Covariance Matrix

	SEC04	TERT04	ILLIT04	LOGGDP04	AGRI04	SERV04
	--------	--------	--------	--------	--------	--------
SEC04	1286.64					
TERT04	630.56	453.99				
ILLIT04	-550.24	-278.84	412.62			
LOGGDP04	49.76	34.19	-21.97	4.91		
AGRI04	-757.86	-389.39	394.69	-30.42	828.53	
SERV04	557.13	302.99	-293.22	22.52	-603.73	477.35
TELE04	7057.00	4164.32	-3027.06	364.94	-4287.76	3217.68
VEHIC04	5361.05	3362.92	-2416.13	265.59	-3456.36	2598.54
SQPOP80	8554.54	9457.54	-1175.21	5432.57	8544.08	-10948.06
RAIN	-4789.51	-3355.20	-621.11	-462.63	4678.85	-3062.77
TEMP	-144.77	-94.81	65.33	-8.66	84.06	-60.61
IOCYEARS	596.33	406.22	-253.74	39.69	-323.09	262.91

Covariance Matrix

	TELE04	VEHIC04	SQPOP80	RAIN	TEMP	IOCYEARS

TELE04	59616.25					
VEHIC04	41503.11	39587.21				
SQPOP80	113895.27	26839.00	17799768.77			
RAIN	-52836.05	-36804.66	-353338.63	741912.46		
TEMP	-1006.69	-861.30	-5391.30	1866.60	46.21	
IOCYEARS	4188.32	3410.24	26733.73	-3035.89	-113.53	642.66

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Ref Type: Unpublished Work

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