Observable and unobservable determinants of a healthy diet in Russia:
A structural equation approach

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ABSTRACT

The Russian Federation is facing crucial dietary problems which burden the health care sector to an increasing degree. In order to correct this trend explanations for the observed mostly unhealthy diets are needed. Therefore the main target of this study was to find evidence about the main determinants of a healthy diet in the Russian Federation based on household production theory. In order to do that a healthy eating index for the Russian population was calculated according to the Diet Quality Index-International and used to describe the nutrition quality of the Russian diet. In a next step an empirical model was developed. In this model sociodemographic/socioeconomic variables were extended by the psychological variables such as overall dissatisfaction, financial dissatisfaction, scepticism/fear, and knowledge. The empirical results do support the hypothesis of a psychological influence on the healthy eating index.

1 INTRODUCTION

In this study the healthfulness of the Russian diet was analysed and related to several well-known determinants such as price, income, observable individual and household characteristics, but also to unobservable psychological determinates such as healthy eating knowledge of family members and emotional states like satisfaction/dissatisfaction and fear. The study is of research interest since special attention should be called to the health status of the Russian population, which is suffering substantially after the breakdown of the socialist system in the late 20th century. The worrying health status can be mirrored by observing several indicators, e.g. life expectancy. According to the Federal States Statistics Service, in 2007 the official life expectancy at birth was 67.5 years for total Russian population (males 61.7 years, females 73.9 years)[1] which is even lower than Russian life expectancy in 1992. Hence Russian men and women face an average life expectancy of 12.9 years shorter than their European neighbours (EU-15).[2]

Non-communicable diseases, such as cardiovascular disease, diabetes mellitus or chronic respiratory disease, actually contribute the lion's share to the worrying morbidity and death rates. In fact, over the past decade Russians have witnessed a dramatic increase in these non-communicable diseases, which are directly related to nutritional behaviour (micronutrient

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[1] In contrast to the gender specific differences in life expectancy the healthy life expectancy is nearly identical for female and male Russians (Valkonen et al. 1997, Andreev et al. 2003 und Suhrke et al. 2007, 21).
[2] Data based on WHO 2010.

deficiencies, unhealthy diets) and lifestyle (e.g. smoking or drinking habits) (Adeyi et al. 2007, 6; Suhrke et al. 2007, 43-45). Drawing on this nutrition related burden this study investigates the determinants of a healthy diet in Russia. According to the WHO economic, social, demographic, behavioural and environmental factors (e.g. lower access to education, lower family members' education, economic precariousness, fewer overall job opportunities and limited access to professional jobs) determine the tendency towards health-damaging dietary and lifestyle behaviour.

However, despite the causal relationship between unhealthy dietary behaviour and the risk to develop NCDs[3] only a few studies focused on the analysis of the main determinates of the Russian diets[4]. These few studies mainly analysed micro determinants of nutritional/lifestyle behaviours (e.g. alcohol consumption) within the Russian population, such as initial levels of consumption, holding a university degree, gender, income and having access to a garden plot. Psychological determinants such as skills, knowledge, stress, fear as wells as satisfaction of e.g. sociological, financial and individual needs or wishes remained so far unconsidered. However as Perlman and Boback (2008, 98) pointed out, psychological factors need to be regarded in further scientific studies of the Russian nutritional behaviour.

Theory of household production (Becker, 1965) provides a framework for this study, in which households combine time, human capital, and purchased goods to produce commodities, such as a healthy diet, in order to maximize a joint utility function (Rosenzweig und Schultz 1983, 724; Variyam et al. 1999, 373). Within this framework it was possible to consider well known observable micro determinates as well as unobservable psychological determinants. For example, the determinant maximal educational level had been shown to have a positive impact on nutritional behaviour in several studies (e.g. Herzfeld 2009, 21; Brosig 2000, 17). However, holding a university degree should no longer been understood as a determinant of food production by itself. Instead it is a factor, which improves the efficiency of healthy food production by an increased and less costly access to knowledge and information (Behrman et al. 1988, 313-314; Variyam et al. 1999, 373-374). Therefore the educational level is only one exogenous variable out of others which measures the non-observable construct "healthy diet knowledge". According to Variyam et al. (1999, 374) demand functions estimated without explicit control of the healthy diet knowledge may overstate the effect of education. Considering this, Variyam et al. (1999, 375) developed a household production model for

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[3] For the relationship between dietary behaviour and the risk to develop NCDs please see Kogevinas et al. 1997, 267-274; Variyam et al. (1999, 373), Boeing et al. (2007, 9-40), Jain et al. (1998, 905-937), as well as DifE/WCRF/AICR: Krebsprävention durch Ernährung. Deutsches Institut für Ernährungsforschung 1999.
[4] Some examples are Herzfeld et al. (2009, 1-4), Huffman, F. K.; Rizov, M. (2007, 379) while not focussing directly on pure dietary behaviour but on lifestyle also.

children's nutrient intake which included mother's healthy diet knowledge as an explicit determinant of nutrient intake.

Since there is little point in studying the effects of income and prices on nutrient intake unless nutrient intake is considered desirable (Behrman et al. 1988, 301), another issue addressed by this study was the calculation of a healthy diet index. This means that in this study instead of individual aspects (e.g. calorie intake or alcohol consumption) a complex index for the healthfulness of the dietary behaviour was applied. Hence the first purpose of this study was to evaluate the healthfulness of the Russian diet as the endogenous variable of the empirical model. In light of the household production theory a second purpose was to include more unobservable psychological determinates than only healthy diet knowledge in the model in order to minimize the ζ error term.[5] Therefore the model of this study needed to be enhanced by other unobservable constructs such as "financial dissatisfaction", "overall dissatisfaction", and "scepticism/fear". Financial dissatisfaction had to represent the bottom financial needs of the Maslow's hierarchy of needs (1943). If these financial needs are not well satisfied the nutrient intake will primarily serve basic needs so as to meet actual physiological needs. But nutrient intake, however, will not be recognised as a possibility to enhance long-term health and therefore self-esteem and confidence. Overall dissatisfaction had to represent higher needs and wishes, such as sociological, educational, and environmental. In this matter it was assumed that actually dissatisfied needs, for example by a bad education, a bad marriage and a terrible environmental situation, would increase the motivation and therefore the energy to satisfy them but promotes in the background long-term motives such as a healthy and confident life. As a result overall dissatisfaction would have a negative influence on the healthfulness of the diet as well. Finally the unobservable determinant scepticism/fear was included in order to find a measure for the individual risk behaviour. According to risk theory it was assumed that a higher level of fear and scepticism is an indicator for risk aversion which in turn increases healthy diet behaviour since a risk-averse person would gather more information and knowledge for a healthier life. Therefore this risk avers person would gain a higher probability of a healthier diet. In summary the following four hypotheses of the study were deducted:

> **H1:** The higher the healthy diet knowledge within the household, the better the healthfulness of the individual diet.

> **H2:** The higher the individual level of financial dissatisfaction, the worse the healthfulness of the individual diet.

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[5] According to Lusk und Briggemann (2009, 184) a model which expresses the interaction of rational thinking (kognition) and affect is of prevailing research interest.

H3: The higher the individual level overall dissatisfaction, the worse the healthfulness of the individual diet.

H4: The higher the individual level of scepticism / fear, the better the healthfulness of the individual diet.

Since financial satisfaction affected by an adequate financial income often leads to the satisfaction of other needs like building up a good environment, and material status symbols for sociological relationships, financial satisfaction will have a positive influence on the overall satisfaction. Or rather financial dissatisfaction will have a positive influence on overall dissatisfaction. Therefore a complex model which allows for interdependent determinants is considered. So as to be able to estimate and test such complex causal relationships, a complex econometric model is needed (Gefen et al. 2000, 4). In a complex econometric model several hypotheses can be tested simultaneously and correlations between the variables are allowed. Additionally, complex economic models allow for intervening variables, i.e. variables which are an independent and dependent variable at the same time (Weiber and Mühlhaus 2010, 3-6). Also, considering the above mentioned psychological variables they have the ability to include unobservable (latent) variables in the model. According to the current state of research the only data analysis method which allows for complex econometric models, the use of unobservable latent variables, and moreover the identification of measurement errors is the structural equation analysis (Fornell 1985, 13; Gefen et al. 2000, 17-18). In contrast structural equation analysis enables scientists to consider a more flexible and powerful model of interactions with correlated independents, measurement errors, correlated error terms, as well as multiple latent independents and dependents. This analysis is based on causal patterns, processes, or systems of behaviour. Although no statistical technique by itself is powerful enough to furnish causal laws of science, structural equation analysis is able to take a step further than previous methods in the analysis of causal systems (Fornell 1985, 9-11). Taking in account all these advantages of structural equation analysis, its use becomes clear for this study.

In conclusion, the analysis of the determinants of a healthy diet in Russia by this study is relevant in two different aspects. First the study adds empirical evidence on healthy diet consumption patterns in Russia. And second, it offers an enhanced view by adding unobservable psychological determinants in the analysis. In order to access these issues, the structure of this article is organized as follows. Section 2 describes the data used, the applied statistical methods of structural equation analysis, and the explorative factor analysis at the level of building the latent constructs. In section 3 empirical results according to the

hypotheses of the study are described and displayed. Here it is shown to which extent prices, income, individual and household characteristics, healthy diet knowledge, financial and overall dissatisfaction, as well as scepticism/fear relate to the healthfulness of the individual diet. Finally in section 4 conclusions are presented.

2 DATA AND METHODS

2.1 Data Description

Data used for the empirical implementation is taken from the Russian Longitudinal Monitoring Survey (RLMS)[6] for the time horizon September 2002 to December 2002. The RLMS is mainly organized and coordinated by the Carolina Population Centre at the University of North Carolina at Chapel Hill. It is based on the Living Standard Measurement Survey, which was set up in 1979 by the World Bank (Deaton 1997, 32). For this study empirical data of the year 2002 belonging to RLMS-round 11 was used. This contains observations of 4,668 households, as well as 10,499 adults and 2,024 children living in these households. Since results would have been heavily distorted by using a mixed data set of adults and children[7], only observations of adults were included in the study. Additionally it was necessary to exclude individuals with a sampling weight of zero.[8] The sample size after deducting children and observations with zero sample weights resulted in 7877 observations.

RLMS data provided a numerous variety of information such as socioeconomic variables, food expenditures, food production and income at the household level as well as health status and dietary intake at the individual level. Respondents were asked to recall expenditures (including the according quantities) spent on food products over the last seven days and other products/services spend over the last thirty days or three months. Moreover, respondents were asked about their psychological situation such as satisfaction in respect to several aspects, e.g. family, finances, fears, aims, and how they see their future. Despite all the useful information of the RLMS there was a number of limitations associated with this study such as misreported data, missing data, and a relatively long period of data collections which included several seasonal distortions in prices and stocks of short life food products such as fresh fruits and vegetables (Manig and Moneta 2009, 4-5).

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[6] We thank the Russia Longitudinal Monitoring Survey Phase 2, funded by the USAID and NIH (R01-HD38700), Higher School of Economics and Pension Fund of Russia, and provided by the Carolina Population Center and Russian Institute of Sociology for making these data available.

[7] Therefore please see Variyam (1999, 379) which found that even within the group of children there are statistical significant differences.

[8] A sample weight of zero was assigned to households and therefore individuals who moved out of the sample area between rounds. Although useful for longitudinal analyses they had to be excluded from the cross-sectional analysis in order to have a representative sample of Russia. (Carolina Population Center 2010)

2.2 Empirical model

According to hypothesis H1 to H4 the causal relationships of the structural model are illustrated in Figure 1.
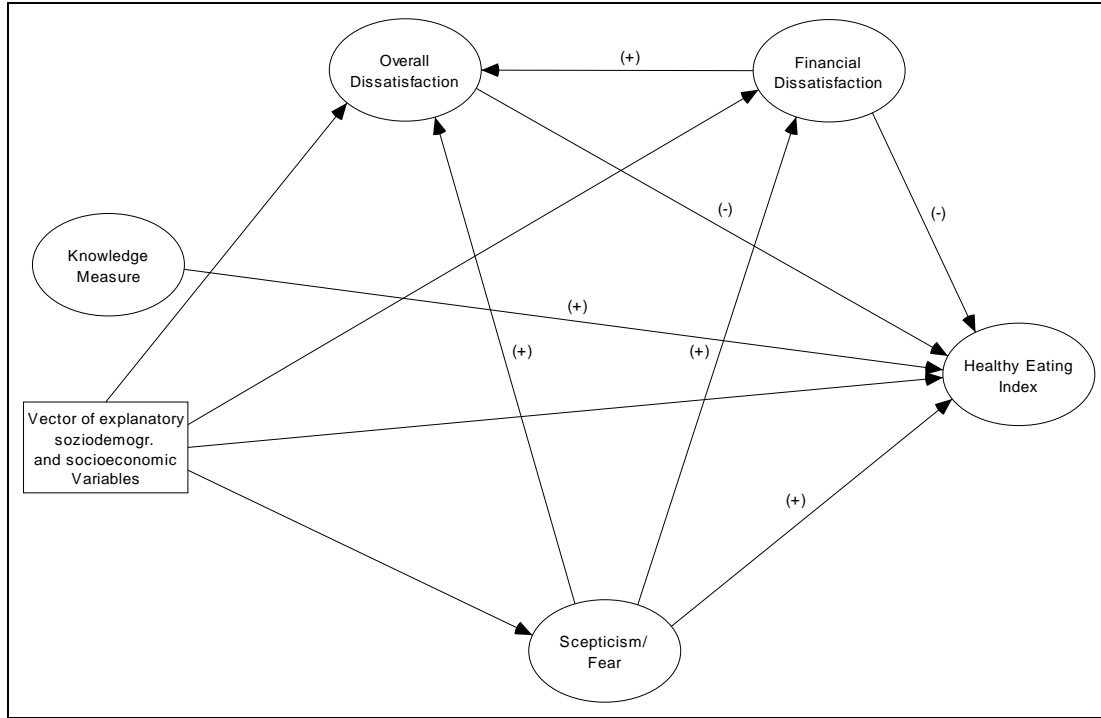

Figure 1: Structural model of the hypotheses system

The empirical version of the household production model, considering the additional hypothesized causal relationships, is specified in this study as follows:

$$(1) \qquad C = \alpha_0 + \sum_{p=1}^{P} \gamma_{CX,p} X_p + \gamma_{CK} K - \beta_{CF} F - \beta_{CO} O + \beta_{CS} S + \zeta_c$$

$$(2) \qquad F = \phi_0 + \sum_{p=1}^{P} \gamma_{FX,p} X_p + \beta_{FS} S + \zeta_F$$

$$(3) \qquad O = o_0 + \sum_{p=1}^{P} \gamma_{OX,p} X_p + \beta_{OS} S + \beta_{OF} O + \zeta_O$$

$$(4) \qquad S = \varsigma_0 + \sum_{p=1}^{P} \gamma_{FX,p} X_p + \zeta_S$$

where C is a measure of the healthfulness of the consumed diet, X is the vector of P different explanatory sociodemographic and socioeconomic variables, K is a measure of the healthy diet knowledge within the family, F is a measure of the individual financial dissatisfaction, O is a measure of the individual overall dissatisfaction and S is a measure of the individual scepticism and fear. Γ is the coefficient matrix of the hypothetical causal relationships

between the exogenous variables and the endogenous variables of the structural model. B is the coefficient matrix of the hypothetical causal relationships between the endogenous variables by the intervening variables. The error term of the endogenous variables is included by ζ.

In order to operationalise the structural model a measure for the healthfulness of the consumed diet had to be identified. Additionally amendments of the data were necessary in order to meet the information required. Finally measurement models for the unobservable (latent) variables had to be expressed. These procedures are described in the following.

2.3 Healthy Diet Measurement

In order to operationalize the healthy diet variable an index had to be calculated rather than simply taking the calorie intake[9] as a measure for the healthfulness of a diet. Several indices were mentioned in literature (Stookey et al. 2000), e.g. Diet Quality Index (DQI), Diet Quality Index-International (DQI-I), Diet Quality Index-Revised (DQI-R), Healthy Eating Index (HEI), Institute of Nutrition and Food Hygiene-University of North Carolina at Chapel Hill Diet Quality Index (INFH-UNC-CH DQI), Diversity Index (Drescher et al. 2007). The DQI-I derives from international and national nutrient guidelines[10] and the food guide pyramid[11] integrated into the information of several diet indices[12] (DQI-I) (Kim et al. 2003). Despite other indices, which were created due to diet-related concerns of developed countries such as USA or the countries of Western Europe, the DQI-I is especially appropriate for international application. This is because it accounts not only for dietary aspects in relation to chronic diseases but also for problems of undernutrition, "thus providing a global tool for monitoring healthfulness of diet and for exploring aspects of diet quality related to the nutrition transition."(Kim et al. 2003, 3476)

Since both aspects, malnutrition related chronic diseases and undernutrition, are present within the Russian Population the DQI-I was a suitable measure to operationalise the endogeneous variable healthy diet. It monitors healthfulness of a diet by assessing variety, adequacy, moderation, and overall balance of the diet applied. For each category as well as for each component within the category scores are allocated and summed up resulting in the total DQI-I score ranging from zero to 100, with 100 being the highest possible score (Kim et al. 2003, 3477-3479). In this study the DQI-I was applied as a measure for the endogenous

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[9] As done by Manig and Moneta (2009). Among other things, the main problem with calorie intakes is that they do not distinguish whether the observed calorie intake variety is the result of the intake of different healthy or unhealthy products
[10] World Health Organization (1996).
[11] U.S. Department of Agriculture (1992).
[12] For example: Patterson et al. (1994); Haines et al. (1999); Kennedy et al. (1995); Stookey et al. (2000).

variable healthfulness of the Russian diet. However since RLMS data did not provide all information necessary, the DQI-I had to be slightly modified. In the following it is described how the four categories variety, adequacy, moderation, and overall balance were operationalised according to the RLMS data.

Variety: Eating a large variety within similar food groups, as well as on an overall level, is internationally recommended for a healthy diet.[13] Therefore the category variety serves as a measure for the overall variety as well as the variety within several protein sources. At the level of the overall variety a maximum score is assigned if at least one serving of food per day came from each of the five food groups (meat/poultry/fish/egg, dairy/beans, grains, fruits, and vegetables). At the level of variety within several protein sources a maximal score is given for a variety between the protein sources meat, poultry, fish, dairy, beans and eggs.[14]

Since the RLMS study did not provide information on servings of food items per day neither on the individual basis nor on the household basis, a proxy for individual variety was needed. In solving that problem information on food items bought and/or home produced by the households was taken and classified according to the appropriate food groups.[15] Such a procedure of substituting nutrition consumption data by nutrition availability is scientific tenable since a merely low rate of wastage can be assumed for the Russian population (Manig and Moneta 2009, 5).

Adequacy: In order to guarantee a healthy diet fruits, vegetables, grains, protein and fat must be supplied sufficiently. According to the DQI-I, scores have to be given on the basis of recommended servings per day. Maximal score in this category is a score of 40 points. Applying the RLMS data led - same as for variety - to the problem of not having the information of individual's servings per food group per day. Therefore household nutrition availability was used again as a proxy for servings per day and was compared to the recommended food group weight shares provided by the nutrition circle of the German Nutrition Society (DGE 2004).[16] In order to meet the recommended food group shares, scores were calculated on the following basis:

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[13] For example see Deutsche Gesellschaft für Ernährung , Vollwertig essen und trinken nach den 10 Regeln der DGE, http://www.dge.de/pdf/10-Regeln-der-DGE.pdf

[14] For further detail of the measurement procedure please see Kim et al. (2003, 3477-3479).

[15] RLMS food expenditure data refers to food items bought in the last seven days. Data about food home production refers to own farm production of the last 12 months. In order to include the effect of stockpiling in the study the amounts of home production per food category was calculated as the weekly average of the last year.

[16] The following recommended shares per food group are displayed by the nutrient circle: grain/grain products/potatoes 30%, vegetables/salad 26%, fruits 17 %, milk/dairy products 18%, meat/banger/fish/eggs 7%, and fats/oils 2%.

$$(5) \qquad ADEQU = \sum_{i=1}^{6} \sqrt{(s_i - \hat{s}_i)^2}$$

where ADEQU is the measure for the overall household deviation from the recommended food group shares, s is the share of each of the six food groups i available in the household, and ŝ is the recommended share per food group i.

Moderation: Moderation specially focuses on the moderate intake of nutrients which are related to chronic diseases e.g. for total fat, saturated fat, cholesterol, and sodium. Since the RLMS data did not provide information on intakes of saturated fat, cholesterol, and sodium in this study other nutrient categories were searched for which needed to be restricted. Restrictions are necessary for the nutrient value (i.e. total calorie per day), the intakes of alcohol, and sugar. These factors were therefore used as indicators for moderation since all of them bear the risk of energy oversupply. Moreover alcohol and sugar have a slight nutrient density aside from carbohydrates and can lead to an imbalance of essential nutrients, aside from other harmful effects.[17]

Information about individual calorie intake as well as the proportion of the energy-yielding macronutrients necessary to construct the categories moderation and overall balance was provided perfectly by the RLMS data. These calorie data was collected based on a 24 hours recall of food consumption. In order to ensure moderation, the individual total calorie intake per day had to be standardized by the recommended optimal calorie intake. Main determinants of the optimal energy requirements of adult populations with different lifestyles are age, gender, body weight and habitual physical activity. At first, depending on age, gender, and body weight the basal metabolic rate was computed for every individual of the RLMS study.[18] Second, the computed individual metabolic rate was multiplied with the habitual physical activity (PAL). For this study PAL was set to a normal physical activity which includes mainly sedentary work with parts of walking and standing (PAL=1.6). The product of individual metabolic rate and PAL lead to person's individual total energy expenditure, i.e. optimal calorie intake per day. Third, moderation scores were calculated based on the ratio of actual calorie intake to optimal calorie intake per day. Additionally to moderation of calorie intake, moderation of alcohol and sugar intake were controlled in this index also. Actual alcohol intakes were related to the maximal recommended alcohol intakes of ten gram for woman and 20 gram for men (for 100% alcohol per volume).

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[17] Therefore sugar and alcohol intake had been included in the dietary moderation score of the Diet Quality Index-Revised (DQI-R) of Haines et al. (1999) as well.

[18] In this calculation the D-A-CH reference values of the German Nutrition Society (DGE), Austrian Nutrition Society (ÖGE), and Swiss Society for Nutrition (SGE/SVE) were used (German Nutrition Society (DGE), Austrian Nutrition Society (ÖGE), Swiss Society for Nutrition (SGE/SVE) 2008, 25-27).

Overall Balance: The forth category, diet's overall balance, refers to the proportionality in the energy sources fibre, protein, and fat.[19] In this field there are several recommendations for the optimal share of the three different energy-yielding macronutrients in their contribution to total energy intake.[20] According to the D-A-CH reference values the optimal macronutrient shares are as follows: carbohydrates 55%, protein 15%, and fat 30%.[21]

DQI-I: Finally the categories variety, adequacy, moderation, and overall balance were summed up to the total DQI-I score applied in this study. Despite the primary aim to enter the calculated DQI-I in the econometric analyses as the dependent variable, it was necessary to refrain from this aim. The calculation process with the above described amendments of the DQI-I separated the categories into two different parts. On one hand the categories variety and adequacy were calculated as proxies by using household data. On the other hand the categories moderation and overall balance were based on individual data. Therefore the total DQI-I computed in this study could not be used as one index in the structural model without allowing for distortions. For application in the structural analysis of this study the DQI-I was divided into the following two dependent variables: variety/adequacy and moderation/overall balance. This separation of the DQI-I made the following amendments of the original hypothesis necessary:

> **H1/1:** The higher the knowledge measure within the household, the better variety and adequacy of the diet.
>
> **H1/2:** The higher the knowledge measure within the household, the better moderation and overall balance of the diet.
>
> **H2/1:** The higher the individual level of financial dissatisfaction, the worse variety and adequacy of the diet.
>
> **H2/2:** The higher the individual level of financial dissatisfaction, the worse moderation and overall balance of the diet.
>
> **H3/1:** The higher the individual level of overall dissatisfaction, the worse variety and adequacy of the diet.
>
> **H3/2:** The higher the individual level of overall dissatisfaction, the worse moderation and overall balance of the diet.
>
> **H4/1:** The higher the individual level of scepticism / fear, the better variety and adequacy of the diet.

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[19] Data for fatty acid ratio, which is included in the original DQI-I, is not given in the RLMS data. (Kim et al 2003, 3479)

[20] For example: Eurodiet Reports and Proceedings (2001), National Academy of Sciences. Dietary Reference Intakes (DRIs 2004), WHO (2003), and D-A-CH reference values of the German Nutrition Society (DGE).

[21] D-A-CH reference values of the German Nutrition Society (DGE), 230ff.

H4/2: The higher the individual level of scepticism / fear, the better moderation and overall balance of the diet.

2.4 Predictor Variables

According to the household production model of equation (1)-(4) the observable explanatory variables of vector X needed to be identified. They were included to control for common family effects which could have influenced the healthfulness of a diet as well as the psychological states of the individual. Therefore the vector of explanatory variables includes sociodemograhic and socioeconomic variables, which are for this study: gender ($\xi 2$), household size ($\xi 3$), average age in the household ($\xi 4$), proportion of females in the household ($\xi 5$), settlement type ($\xi 6$), working status ($\xi 7$), households price index for the average Russian food basket ($\xi 8$), total household expenditure ($\xi 9$), and age ($\xi 10$). This data was either directly provided by the RLMS data or needed to be computed. One adjustment due to the limitations of the data was the use of total expenditure as a proxy for permanent income.[22]

There were several variables in the structural model which could not be measured directly. Therefore measurement models for the unobservable (latent) variables were necessary. Measurement models include instructions how the latent constructs, in this study healthy eating knowledge, overall dissatisfaction, financial dissatisfaction, and scepticism/fear, can be measured by several observable (manifest) indicators.

All four latent variables of the model were expressed as reflective indicators. The decision in favour of reflective measurement models was indicated by the fact that the latent constructs influence the values of the according manifest indicators.[23] A reflective measurement model needs at least three observable indicators to be identified (Diamantopoulos et al. 2001, 270–271). In order to test for one-dimensionality of the applied observable indicators the explorative factor analysis (EFA) was used. For every construct one isolated explorative factor analysis was conducted.[24]

2.5 Model Estimation

Simultaneous estimation of a structural equation model based on an empirical variance-covariance matrix was developed by Jöreskog (1970). The variance-covariance approach is

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[22] Arguments for taking total expenditures instead of permanent income were that income data reported probably had to face several limitations such as wage arrears and delayed wage payment and misreporting. Moreover total expenditures may be a better indicator for both declared and undeclared household resources. This is especially true at low income groups. And finally they seem to reflect the possible long-term income better than survey income data. (Manig and Moneta 2009, 4)

[23] This argument does not hold for the knowledge measure but was, in this preliminary version, a necessary assumption in order to use AMOS.

[24] Principal axes factor analysis with Promax rotation (Weiber and Mühlhaus 2010, 107). Test statistics of the reliability of the indicators are Barlett's test and measure of sampling adequacy (MSA, or Kaiser-Meyer-Olkin-criteria KMO).

implemented in the statistical program AMOS[25] which was applied for this study. In the variance-covariance approach latent variables are interpreted as factors behind the manifest variables. Therefore in the estimation process factor loadings were estimated by fitting the model variance-covariance matrix to the empirical variance-covariance matrix best possible (Weiber and Mühlhaus 2010, 47). Equations (1)-(4) were restated into the standard structural equation model framework with latent variables. In this framework all variables were expressed as deviations from their means, so the intercept coefficients were set to zero (Variyam et al. 1999, 377).

Error terms in these structural equations are distributed independently but may be correlated across either the exogenous or endogenous variable error terms. Because of these correlations, ordinary least square (OLS) estimates of the parameters of equations (1)-(4) would have been inconsistent. Hence, in order to minimize the discrepancy function between model and empirical variance-covariance matrix, several other estimation algorithms were suitable. In case of AMOS 7 these were Maximum Likelihood (ML), Generalized Least Square (GLS), Unweighted Least Square (ULS), Scale Free Least Square (SLS), and Asymptotically Distribution Free (ADF). Based on a multivariate non-normal distribution of the observable RLMS data used in the model, a relatively large sample size of 7877 cases (4278 cases after elimination of missing data with MCAR assumption), and the necessity of scale invariant estimation function with inferential statistics the ADF estimation algorithm was chosen. At large sample sizes[26] "(t)he minimal distributional assumptions on which the ADF method is based should make it the method of choice for models with non-normally distributed variables." (Finch et al. 1997, 101)

3 RESULTS

In presenting the empirical results focus was set first on the calculated DQI-I as an indicator of the healthfulness of the diet and second on the model estimations.

3.1 DQI-I

The frequency distribution of the calculated DQI-I, as a total of variety/adequacy measured by household proxies and individual's moderation/overall balance, is presented in Figure 2.

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[25] Arbuckle, J. L. (2006). Amos (Version 7.0) [Computer Program]. Chicago: SPSS.
[26] Minimal sample size for using ADF differs. Backhaus et al 2006 N>500; Nevitt and Hancock 2001 N>1000, Weiber and Mühlhaus 2010 N> 1.5*t(1+t) with t=free parameters, Finch et. al. 2010 at least N > 500, but with N>1000 ADF results better than ML in case of non-normality.
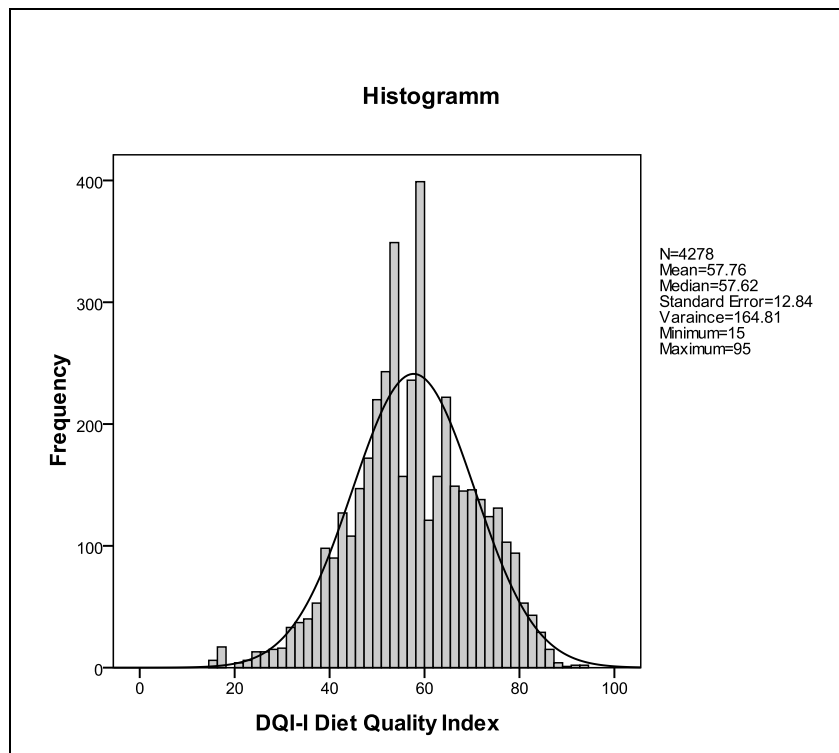
Figure 2: Frequency Distribution of DQI-I within Russian Population.

Table 1 provides a comparison of the original DQI-I scores calculated by Kim et al. (2003, 3480) for the Chinese and US-American diets and the scores calculated in this study for the Russian diets. Although these values do not provide an exact basis for detailed comparisons they may draw a picture of the differences between these countries.

Component	Score Ranges	Russian Federation	China	United States
N		4278	8352	9768
DQI-I. total	0–100 points	**57.76 ± 0.19**	60.5 ± 0.11	59.1 ± 0.14
Variety	0–20 points	**14.72 ± 0.05**	11.8 ± 0.06	15.6 ± 0.04
Adequacy	0–40 points	**24.68 ± 0.10**	28.0 ± 0.05	28.1 ± 0.08
Moderation	0–30 points	**14.46 ± 0.14**	18.6 ± 0.10	14.3 ± 0.08
Overall Balance	0–10 points	**3.90 ± 0.06**	2.1 ± 0.04	1.1 ± 0.02

Table 1: Russian DQI-I in Comparison with Chinese and American DQI-I

For a more detailed comparison of dietary and lifestyle behaviours between Russians, Americans, and Chinese Table 2 provides information on the dietary macronutrient ratios, of the percentages of total fat calorie intake, and alcohol intakes. As can be seen in direct comparison, the Chinese actual macronutrient ratio fitted the recommended macronutrient ratio at best. Looking at the diet of Americans and Russians it is noticeable that 84.1% of the observed Americans have a macronutrient ratio which is even worse than the broadest measured range of 50-70% carbohydrates / 8-17% proteins / 12-30% fats. However, only 74.8% of the observed Russians lie outside this ratio. Looking at the fat percent of total

energy intake, again the Chinese do follow the recommended fat calorie to total calorie ratio of less than 30% at best. Only 34.9% of the observed Chinese have a total fat ratio of more than 30%. In contrast, 63.4% of the observed Russians and 67.1% of the observed Americans have a total fat ratio of more than 30%. The differences between Russians and Americans in total fat calorie aspects are quite low. But considering the alcohol intake important differences are noticeable between Americans and Russians. 88.2% of Americans but only 42.3% of Russians lie below the recommended critical value of one serving per day. Moreover, only 6.1% Americans but 52% of Russians have more than two servings of alcohol per day.

Basic Index	Scoring Criteria		Russia	China	United States	United States
			RLMS 1992. 24-h recall	CHNS 1993. 24-h recall	CSFII 1994-96. 24-h recall	CSFII 1994. 2-day recall
			N=4.278	N=8.269	N=9.218	N=3.202
DQI-I	Macronutrient ratio (carbohydrate/protein/fat)					
	Best	55 to 65%/10 to 15%/15 to 25%	0.0	4.8	1.2	
		52 to 68%/9 to 16%/13 to 27%	12.2	14.0	5.1	
		50 to 70%/8 to 17%/12 to 30%	13.0	15.6	9.6	
		Otherwise	74.8	65.6	84.1	
DQI-I	Total fat					
	Best	less than 20% of total energy/d	8.2	33.7	5.5	
		20 to 30% of total energy/d	28.4	31.5	27.4	
		more than 30% of total energy/d	63.4	34.9	67.1	
DQI-R	Total fat					
	Best	less than 30% of total energy/d	36.6			32.2
		30 to 40% of total energy/d	38.3			48.1
		more than 40% of total energy/d	25.1			19.7
DQI-R	Alcohol Intake					
	Best	less than 1 serving/d (100%)	42.3			88.2
		100 to 150%	3.2			3.4
		150 to 200%	2.5			2.3
		more than 200%	52.0			6.1

Table 2 Direct Comparison of Macronutrient Ratio and Total Fat Intake.

3.2 Structural Equation Model

Now the focus of the results will be set on the empirical model. In order to evaluate the secondary model, a closer look had to be first taken at the overall model fit. A good model fit is achieved if variances and covariances deriving from the estimated model parameters do fit the empirical variances and covariances. Two different groups of fit criteria exist in literature – inferential statistical and descriptive statistical fits. These fit measures are presented in Appendix 1. For inferential statistics the Likelihood-Ratio $\chi2$ test is not significant. However the Likelihood-Ratio is not applicable for larger sample sizes and non-normally distributed data. By default models with larger samples are rejected as it happened to the empirical model

of this study.[27] In order to solve this problem, the Root-Mean-Square-Error of Approximation (RMSEA) is recommended. The RMSEA tests if the model is able to approximate the reality. A RMSEA lower than 0.05 indicates a close model fit. Therefore the RMSEA of the secondary model with a value of 0.04 underlines a close model fit. This result is also supported by the 90% confidence interval [0.039; 0.041] and pclose of 1.0.

Descriptive fit indices, as well, indicate a close model fit since both Goodness-of-fit Index (GFI) and Adjusted-Goodness-of-fit Index (AGFI) provides values which are higher than 0.9. Additionally the Standardized Root-Mean Square Residual (SRMR) of 0.049 supports with a value lower than the cutoff-value of 0.10 the assumption of a close model fit. In case of the secondary model SRMR is even lower than the stricter cutoff-value of 0.05 asked for by Homburg et al. (2008, 288) (Weiber and Mühlhaus 2010, 157-167).

Local model fits are given first by Squared Multiple Correlations (SMC), second by t-tests of the loadings and path coefficients, and last the standardized regression weights. SMCs indicate how many percent of the variance of endogenous variables are explained by their predictor variables. They can be interpreted similar to the coefficient of multiple correlations R^2 of a linear regression analysis. However there are no recommendations or cutoff-values for SMCs in a covariance structure analysis. Therefore recommended values of the Partial Least Squares approach (PLS) will be used for the variance-covariance based SMC values. SMCs of at least 0.19 indicate a weak effect on variance, values of more than 0.33 indicate a moderate effect, and SMCs higher than 0.66 indicate a substantial influence (Chin 1998b, 323; Weiber and Mühlhaus 2010, 181). Please see Appendix 1 for the SMC values of the local model fit measurement. In the secondary model it is estimated that the predictors of financial dissatisfaction explain 33.9 percent of its variance. Therefore the local construct financial dissatisfaction has a moderate fit only. The same is true for overall dissatisfaction. However for the healthy eating variety/adequacy the influence of the estimated predictors is only weak and for moderation/overall balance it is even lower than weak. Therefore both measures contain substantial measurement errors as evidenced by their SMCs.

Table 3 presents the regression weights of the structural equation model which was tested after leaving out all non-significant relationships of the primary model. Therefore all

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[27] The Hoelter test indicates that Likelihood-Ratio test would have accepted the model at α=0.05 level only if sample size had been not more than N=610. This is clearly not the case of this study.

regression weights with a significance level lower than 0.10[28] were included in this secondary model and are listed below.[29]

		Unstandardized Estimate	S.E.	Standardized Estimate	C.R.	P
Scepticism/Fear	<--- Gender	-.216	.016	-.215	-13.543	***
Scepticism/Fear	<--- Weighted Price Index	.010	.004	.055	2.595	.009
Scepticism/Fear	<--- Average Age in HH	-.007	.001	-.176	-9.821	***
Scepticism/Fear	<--- Knowledge	.118	.037	.092	3.194	.001
Financial Dissatisfaction	<--- Scepticism/Fear	-.739	.030	-.495	-24.278	***
Financial Dissatisfaction	<--- Household Size	-.078	.010	-.146	-7.424	***
Financial Dissatisfaction	<--- Settlement Type	-.290	.031	-.162	-9.332	***
Financial Dissatisfaction	<--- Weighted Price Index	-.038	.006	-.136	-6.388	***
Financial Dissatisfaction	<--- Working Status	-.096	.025	-.063	-3.897	***
Financial Dissatisfaction	<--- Average Age in HH	.004	.001	.063	3.347	***
Overall Dissatisfaction	<--- Financial Dissatisfaction	.434	.021	.560	20.317	***
Overall Dissatisfaction	<--- Average Age in HH	-.008	.001	-.175	-9.218	***
Overall Dissatisfaction	<--- Weighted Price Index	.023	.004	.109	5.864	***
Overall Dissatisfaction	<--- Working Status	-.090	.019	-.076	-4.794	***
Overall Dissatisfaction	<--- Gender	.072	.017	.062	4.164	***
Overall Dissatisfaction	<--- Household Size	.026	.007	.062	3.487	***
Variety/Adequacy	<--- Knowledge	1.421	.630	.065	2.255	.024
Variety/Adequacy	<--- Average Age in HH	.077	.009	.120	8.208	***
Variety/Adequacy	<--- Weighted Price Index	1.610	.115	.510	13.972	***
Variety/Adequacy	<--- Financial Dissatisfaction	.387	.177	.034	2.185	.029
Moderation/Overall Balance	<--- Knowledge	1.852	.627	.084	2.952	.003
Moderation/Overall Balance	<--- Household Size	-.295	.101	-.048	-2.920	.003
Moderation/Overall Balance	<--- Gender	-2.643	.245	-.154	-10.787	***
Moderation/Overall Balance	<--- Average Age	-.052	.012	-.080	-4.381	***
Moderation/Overall Balance	<--- Working Status	-1.481	.276	-.085	-5.364	***
Moderation/Overall Balance	<--- Weighted Price Index	.531	.064	.168	8.232	***
Moderation/Overall Balance	<--- Financial Dissatisfaction	-.506	.191	-.044	-2.646	.008

Table 3: Path Coefficients of the secondary SEM

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[28] Variyam et al. (1999) used in their study a significance level of $\alpha=0.10$, which is common in testing psychological constructs.
[29] There is to mention that for variance based SEM it is stated that paths which are significant but standardized path coefficient of less than 0.10 represent at best only a one-percent explanation of the variance (Chin 1998a, 8). This gives reason to work on better constructs and an empirical model which is based on a clear theoretical framework.

The regression weights and significance levels provide direct evidence to support the hypothesis that knowledge has a positive influence on variety/adequacy and moderation/overall balance of the diet. This underlines the allocative efficiency effect of the latent knowledge construct indicated by knowledge of females in the household, education, and information availability by internet access. This allocative effect was stressed in studies for children's nutrient intake such as by Variyam et al. (1999). With the results of this study the effect can be shown at the level of adults also. Therefore empirical results support the hypotheses H1/1 and H1/2. There is also a significant effect of financial dissatisfaction to the healthy eating scores. However the results do not provide the hypothesised effect of H2/1 which had to be rejected. A higher level of financial dissatisfaction leads to a higher level of variety and adequacy. One possible explanation is that financial dissatisfaction which is negatively influenced by rural settlement, larger household size, and working status leads to more household farm production. This farm production as a result of a financial dissatisfying situation leads to more variety and adequacy of the available food items and indicates the importance of the household farm production as a necessary variable in the future empirical work. Looking at the individual level of moderation and overall balance the hypothesised negative impact of a financial dissatisfaction on the healthfulness of the diet can be accepted by the empirical data. Therefore H2/2 is supported by the empirical data. The higher the financial dissatisfaction the worse the individual moderation and overall balance of the diet is. Hypothesis H3/1, H3/2, H4/1, and H4/2 which describe the effect of overall balance and scepticism/fear on the healthfulness of the diet have to be rejected by the empirical model. These relationships were statistically not significant in the primary model and therefore excluded in the secondary model, which was presented here.

Additionally, the empirical data indicated other explanatory determinants that have statistical effects on the healthfulness of the diet, e.g. gender, household's price index for the average Russian food basket, household size, and working status on moderation and/or overall balance of the individual data.

4 DISCUSSION

In this preliminary study a healthy eating index for the Russian population was calculated and used to describe the nutritional quality of Russian diets. Also an empirical model was developed in order to analyse important determinates of the healthfulness of the Russian diet. In this model sociodemographic/socioeconomic variables were extended by inclusion of the psychological variables overall dissatisfaction, financial dissatisfaction, scepticism/fear, and knowledge. The empirical results do support the hypothesis of psychological influences on

the healthy eating indices but need to be interpreted carefully since standardized path coefficients and SMCs were too low. Therefore in a next step further work has to be done in order to create more powerful constructs and use a longitudinal structural equation analysis. Furthermore adequate missing data imputation methods have to be found and applied. Missing data was an important problem in this study since zero values are often not indicated by clear zero but simply by leaving out an entry in the questionnaires. Hence it was difficult in the analysis to distinguish between clear zero values and missing data at random. A next challenge will be that additionally to the covariance based structural equation model the variance based PLS approach should be tried in order to include formative constructs for sociodemographic/socioeconomic constructs and to count for the non-normally distributed data.

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Appendix 1

Inferential Statistical Fit Indices				
Likelihood-Ratio test				
Chi-square	2.954.763			
Degrees of freedom	375.000			
Probability level	0.000			
RMSEA				
Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	0.040	0.039	0.041	1.000
Independence model	0.076	0.075	0.077	0.000
Descriptive Fit Indices				
RMR				
Model	RMR	Standardized RMR		
Default model	1.784	0.049		
Saturated model	0.000			
Independence model	6.826			
GFI				
Model	GFI	AGFI	PGFI	
Default model	0.986	0.981	0.745	
Saturated model	1.000			
Independence model	0.943	0.939	0.884	
Local Parameter Evaluation				
SMC for Variety/Adequacy	0.29			
SMC for Moderation/Overall Balance	0.10			
SMC for Overall Dissatisfaction	0.33			
SMC for Financial Dissatisfaction	0.34			