The Dimensional and Axial Structure of the BigFive Plus Inventory

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Abstract. This study reports on the adaptation of a personality inventory for the item response models by investigating its structure in order to identify unidimensionality and local independence. We started with the classical form of the BigFive Plus Inventory (Constantin T. , et al., 2008) and we used different techniques to refine the instrument and to identify the structure of the latent traits. First, we analyzed the distribution of observed data within each latent trait. Second, we performed a complete analysis of internal consistency to identify the items-scale relationships and the opportunity to perform a principal component analysis. Third, we performed a principal component analysis using categorical data (CATPCA), and based on centroids and vector coordinates we identified the structure of latent factors. 4647 participants from different socio-economic backgrounds, including students, corporate employees and employees of military structures took part in the study. The results revealed the dimensional structure of BigFive Plus Inventory and the procedures that need to be applied to achieve unidimensionality.
***Key words*:** dimensional structure assessment, CATPCA, internal consistency, personality, psychological tests

I. Introduction

Construction of a psychological assessment tool based on item response theory requires compliance with two key assumptions: unidimensionality – an assumption according to which the items measures only one latent trait and local independence – which postulates that while the latent trait is isolated subjects' responses to items are independent. To meet these assumptions, different techniques may be used. Because the unidimensionality refers not only to the presence of a single latent trait, but the existence of a dominant dimension that influence the test performance

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(Hambleton, Swaminathan, & Rogers, 1991), the eigenvalues and scree-plot method can be used. Other popular methods for assessing unidimensionality are the Stout T test of essential unidimensionality (Stout, a nonparametric approach for assessing latent trait unidimensionality., 1987) also known as the DIMTEST, NOHARM methods based on residual standardized covariance (McDonald, 1967), (Fraser & McDonald, 1988), the clustering method (Debelak & Arendasy, 2012) and the Martin-Löf test (Christensen & Kreiner, 2007). For local independence, Yen's Q_3 test can be used (Yen, 1984) or simply the assumption of the independence of observations used in the internal consistence can be tested.

All these techniques are omnibus methods. It provides a unique statistic of unidimensionality or local independence but does not provide information about the internal structure of the latent traits. Our approach is to investigate the in-depth the structure of the latent traits based on consistency and principal component analysis to identify possible secondary dimensions or axes in the latent trait as well as the items that saturates it.

On this background, the purpose of this study is to analyze the internal structure of the BigFive Inventory factors and to model the items in order to achieve unidimensionality, needed for a 2PL IRT adaptation. First, we need to investigate the univariate distributions of the factors to assure the type of techniques used for consistency and principal component's analysis. Then we will perform a scale consistency investigation to analyze the item-scale relations. Finally, a principal component analysis will be performed to investigate in-depth structure of the latent trait.

This research was based on a single psychological assessment tool, and it was selected to illustrate the possibility of item response modeling for personality inventories. The BigFive Plus Personality Inventory (Constantin & Macarie, 2012) is based on the theory of Costa and McCrae (Costa & McCrae, 2003) and assesses a number of five personality dimensions, each dimension having a composition of six factors (facets). Each factor is measured by a number of eight dichotomous items. The result is a comprehensive inventory, consisting of 240 dichotomous scored items, perfectly appropriate for item response theory adaptation.

Costa and McCrae (2003) treat the five personality dimensions as causal situations; their theory is primarily empirical. They distinguish between basal trends and adaptive characteristics of individuals, the personality traits considered as basal trends, targeting individual potential, but attitudes, roles, relationships and goals are adaptive features that reflect the interaction between basal trends and the environment (Costa & McCrae, 2003).

Constantin & Macarie (2012) describe how the questionnaire's construction began in the fall of 2006, based on the model proposed by Goldberg (1999). The authors adjusted the constructs' descriptions to

appropriately fit into the Romanian culture. The items were generated in panel for each dimension's factor. Initially, there were over 200 items for each dimension, the first form containing about 60 items per dimension, 10 for each factor. The original version, used for a pre-test, consisted of 306 items, 60 items for each dimension; an additional number of six items for a factor that was later removed. Internal consistency analysis led to good indicators for all five dimensions (Constantin et al., 2008).The review of the instrument led to reducing the number of items to 30 for each dimension. In order to optimize the items, the authors proceeded to reform and eliminate, adjusting the content to the understanding level of the general population. Samples of behaviors were condensed, leading to the current version of 240 items, each factor being represented by eight items. This is the version that we used in our study.

In its present form, the test was built on the classical theory of psychological tests. Although the authors reported acceptable psychometric properties, the test is flawed by the limits of this theory, the most important being circular dependency (the sample of items depends on the sample of subjects, and the sample of subjects depends on sample items). The references to a normative sample in order to standardize the scores are considered in a second important limitation.

The item response models solve most of the problems of the classical theory of the test. Both items and subjects are represented in the same continuum, turning the ordinal scale into a real interval scale of measurement. The role of our study is to adapt the personality inventory items for item response theory, resulting in a more robust test. To achieve this, it is necessary to go through a number of preliminary steps: distribution analysis, a study of internal consistency and a separate study of internal structure of the inventory.

II. Method

Participants

4647 subjects (2598 men, 1613 women, M_{age}=33.27 years, age range 14-77 years, 260 middle school education, 2581 high school education, 1537 university studies, 198 post-university studies) participated; the data were collected during a regular assessment process in companies or other institutions as well as in the classes activities with students. Only the complete scores were retained; the subjects with missing scores were removed. The data collection process was performed using both classical and computerized administration of the BigFive Plus and did not form a representative sample.

Materials and Procedure

Before the study of the items, we initiated an univariate analysis of factors and dimensions, knowing that further processing of data involves the compliance of the assumptions related to symmetry and homoskedascicity of distributions.

Scalar consistency was analyzed for each of the 30 factors and five dimensions. We performed these analyzes because inconsistent items can lead to invalid factor analysis models. In addition, we intend to provide an indicator of scale reliability based of internal consistency coefficient Cronbach Alpha and to test if the items can be used in classical factorial analysis. We assessed the additivity assumption by Tukey's non-additivity test and the presence of multiplicative interactions between items as well as multivariate normality assumption using Hotelling's t^2 test.

We prefer to extract principal components using categorical data through the CATPCA method which allows for a more accurate modeling of the data obtained. Initially, the subjects' responses were coded 0 and 1 in the database, this allocation having purely categorical significance, without the existence of any relationship of order. Because the CATPCA does not accept null values, assimilating 0 due to a lack of response, we proceeded to rekey value 0 with value 2. As the items are not ordinal or parametric, the operation is perfectly legitimate.

In terms of factors, the theoretical amplitude is between 0 and 8 points. Because these scales are similar to an interval level, we proceeded to categories discretization based on ranking because the scale did not meet the normality distribution – as we will see later. In addition, in order to increase the accuracy of the analysis, the subjects who did not provide data to at least one of the items were removed.

Normalization was based on optimizing the correlation between variables, the "Variable principal" method being perfectly adequate for this purpose. The convergence criteria were set at .000001 and the maximum number of iterations was 100. Missing cases were removed; all data processing was performed with only valid scores. The ratio is more than 1:500 for the factors and over 1:667 for dimensions, which indicates the relevance of the analysis. At the factor level, the scales were defined as nominal, and for dimensions they can be similar to the ordinal.

III. Results

Univariate normality assessment

None of the variables has a normal distribution (see appendix). Most variables are characterized by platikurtic distributions with a high variability of scores. This is due to the theoretical amplitudes of the scales (8 points), insufficient data to create various options, as well as some asymmetry problems. The concentrations of the scores in the zone of high values or sometimes, in the zone of low values, have also lead to problems of this type. We have also considered that there may be structural imperfections of the items identified in the principal components' analysis or natural tendencies of some of the factors towards such an evolution. Although very large, the research group does not have characteristics of representativeness. It contains subjects somewhat selected from different social backgrounds and being at different education levels. It is possible that this aspect influenced the results.

The fact is that the basic assumptions are not met for the use of parametric procedures, therefore we will consider the use of non-parametric techniques for principal components' analysis.

Scale consistency analysis

Because modeling based on item response theory envisages unidimensionality, the focus is on analysis of the factors, not the dimensions. We note that a rather small number of factors exceed a threshold of .7 for internal consistency (see Figure 1). Only "Gregariousness" (.750), "Cheerfulness" (.703), "Anger" (.793), "Vulnerability" (.760), and "Cautiousness" (.757) meet the criteria of scale consistency for classical factor analysis. Most of the factors show an internal consistency between .6 and .7, below the threshold, and 8 factors present problems related to internal consistency, the coefficient being below .6 ("Morality" (.537), "Modesty" (.572), "Immoderation" (.591), "Dutifulness" (.530), "Achievement-striving" (.423), "Self-discipline" (.586), "Intellect" (.486) and "Liberalism" (.498)). These factors should be excluded from further analysis because of a very small scale consistency. However, we will check the internal structure of all factors to see if the sources of inconsistency are due to errors or due to the particular structure of the factors.

Multivariate normal distribution assumption was achieved in all the analyzed factors. However, additivity criterion was not reached in any of the factors. This is due to the dichotomous nature of the items and the relatively small number of items per factor (maximum 8), and this is not an error.

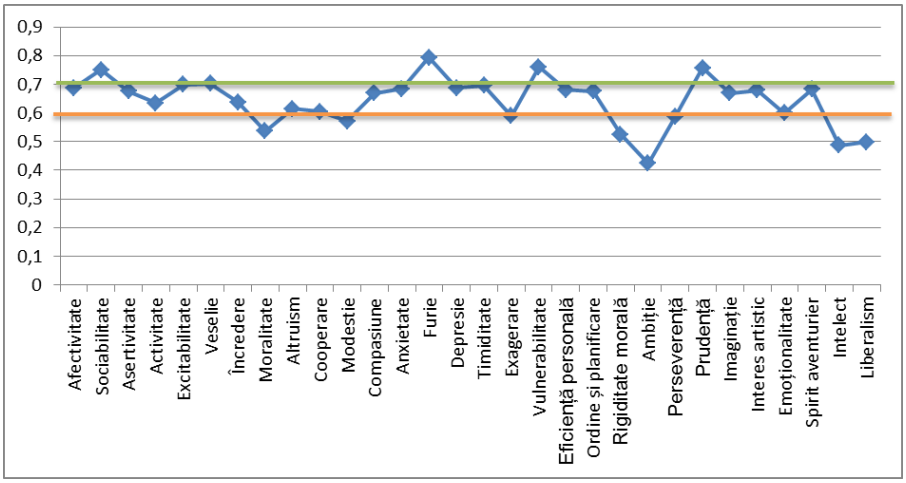

Figure 1 Internal consistency for each factor of BigFive Plus

Principal component analysis and internal structure of the factors

The principal component analysis was based on vector coordinates, thus identifying the possible multidimensional or axial structure of the factors.

Friendliness

An item (37) was reversed, and no items were identified to be eliminated. Apparently, the factor shows a multidimensional model, the second dimensions being determined by different saturations of items 7, 13 19, respectively 25, 31 and 43. These two groups of items determine the meaning of the second dimension. Friendliness can be in relation with friends, acquaintances or in connection with strangers. Clearly, all items are able to explain 31.88% of factor's variance, which is the main dimension, friendliness (eigenvalue= 2.55), but a second dimension was revealed and able to explain 13.07% of variance (eigenvalue=1.05), determined by the two sets of items, which we named *contextual friendliness*. Even if the second component cannot be considered a real dimension, it is important for the assessment so that we can retain it as a guiding axis of friendliness.

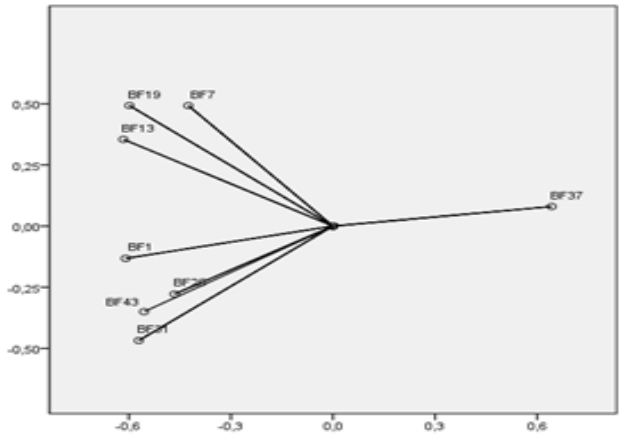

Figure 2 – Items' coordinates for factor Friendliness

Gregariousness

An item (20) was reversed but no items need to be removed from this model. A one-dimensional model was identified and was able to explain 36.65% of variance (eigenvalue=2.93). A secondary axis was also revealed and seems to be important. It can explain 12.42% of variance (eigenvalue=.994) and is determined by different positions of items 8, 14 respectively 20, 32 and 38. In this case, the main dimension is represented by the factor. We can label the second dimension *orientation of gregariousness***.** This dimension distinguishes between gregariousness expressed through behavior, through relationships and social interactions (direct gregariousness) as well as the need for gregariousness, unmanifested, in the form of internal feeling, positively or negatively, expressing needs for social interaction, satisfied or not.

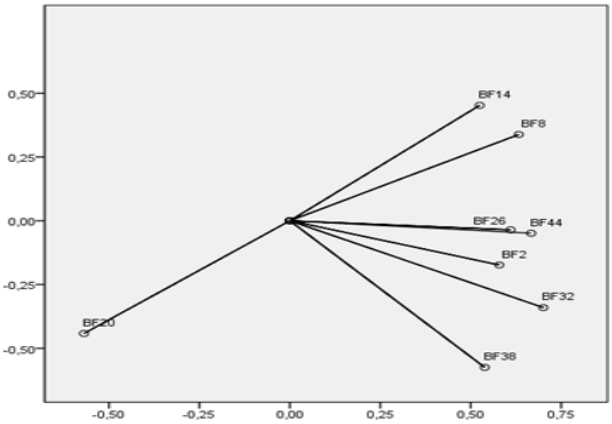

Figure 3 – Items' coordinates for factor Gregariousness

Assertiveness

Factor analysis resulted in a two-dimensional model. The first component can explain 31.56% of variance (eigenvalues=2.52) and the second covers about 13.68% of variance (eigenvalues=1.09) and is determined by items 21, 33 and 45, respectively 15 and 39. The first component can be clearly identified with the general assertiveness factor. The second, named *contextual assertiveness*, seems to be a dimension rather than a simple axis. It distinguishes between assertiveness in terms of job relationship and assertiveness in the social communication process, including involvement in a group and group coordination.

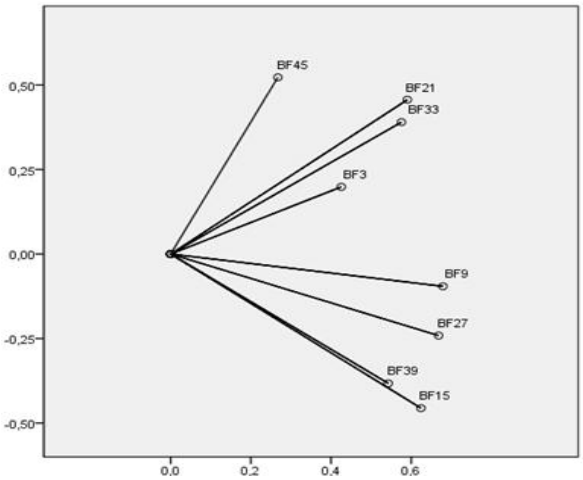

Figure 4 – Items' coordinates for factor Assertiveness

Activity level

A two-dimensional model was revealed. The first component is purely named *general activity level* and is assimilated to the factor, explaining 28.87% or the item's variance (eigenvalue=2.31). The second is an important guiding axis, maybe a component and can explain 16.5% of the variance (eigenvalue=1.32). Its significance is determined by items 4, 28 and 46 for the high saturations in the second component and 10, 22 and 34 for the low saturations. In this case, we can come to the conclusion that the second component distinguishes between the professional activity level and common one, the and habitual activity level; we can name the component as *contextual activity level*.

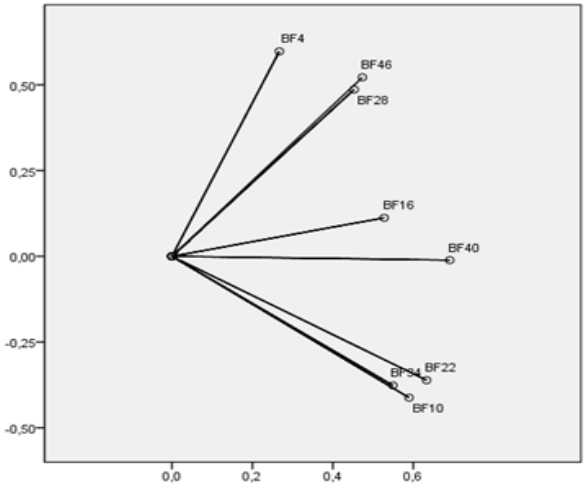

Figure 5 – Items' coordinates for factor Activity level

Excitement seeking

In addition, two components were identified. The most important is the first component that may explain 32.97% of item's variance (eigenvalue=2.63). The second is related to 13.77% of variance (eigenvalue=1.1) but critical analysis of the items could not identify the meaning of this dimension. Our investigation concludes that subjects wrongly perceived a number of two items (17 and 47). By reformulating some response options or by removing these two items we achieved a one-dimensional model for this factor.

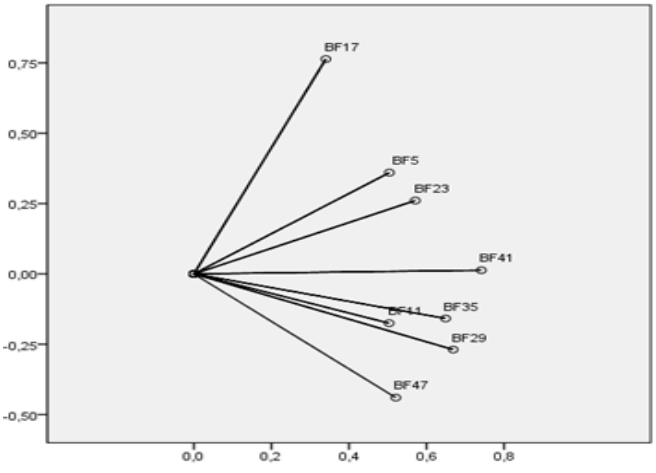

Figure 6 – Items' coordinates for factor Excitement seeking

Cheerfulness

Similar to the gregariousness factor, this factor has good scalar consistency and the principal component analysis reveals a one-dimensional model that can explain 33.72% of variance (eigenvalue=2.69). A second axis was also identified; it was able to explain 12.35% of variance (eigenvalue=0.98), but that is not statistically relevant. In fact, a number of two items (18 and 42) do not seem to be part of the operational context of the construct. Indeed, these items heavily saturate the second dimension (18(.636), 42(.687)); eliminating them led to a model with a single dimension.

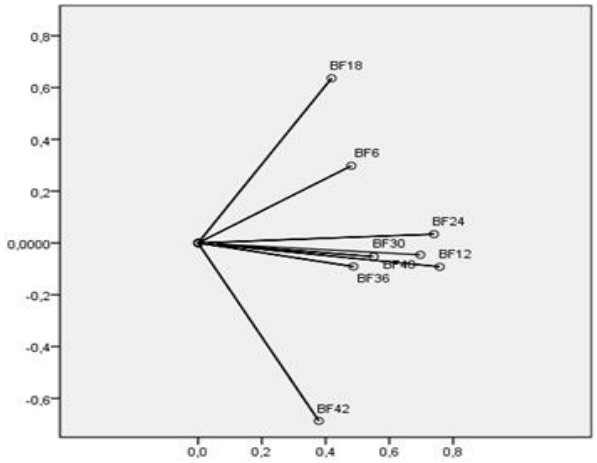

Figure 7 – Items' coordinates for factor Cheerfulness

Trust

The analysis indicates a model composed by a dimension and a guidance axis for this latent trait. The dimension can explain 29.13% of item's variance (eigenvalue=2.33), and the axis explains 13.11% of variance (eigenvalue=1.04). The items are strongly scattered around the second dimension, but the significance of the second component can be explained by critical analysis of the items 85 and 79. Thus, the second dimension, named **trust context**, distinguish between trust in professional activities, characterized by formal tasks and the trust in social, informal activities.

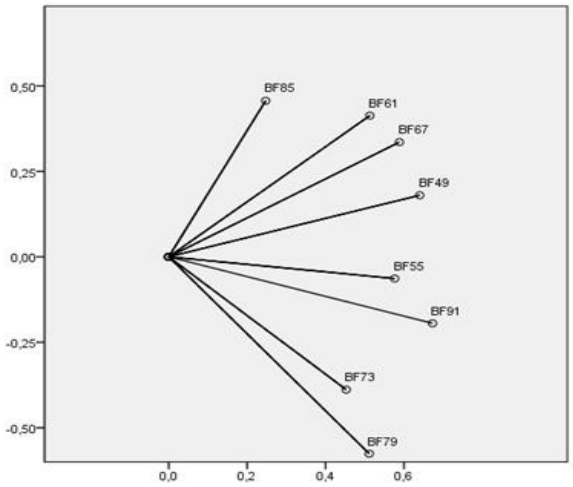

Figure 8 - Items coordinates for factor Trust

Morality

This latent trait did not reach the minimum scalar consistency level even by removing item 80. We can note that the reason for the inconsistency is represented by item 74 in this 7 item model. By studying this item, we noted that it is not a part of the operational definition of the construct. The item refers to something else (actually curiosity not morality), unrelated to the concept of morality. Once item 74 was removed a very good one-dimensional model for the latent trait, composed by 6 items, emerged.

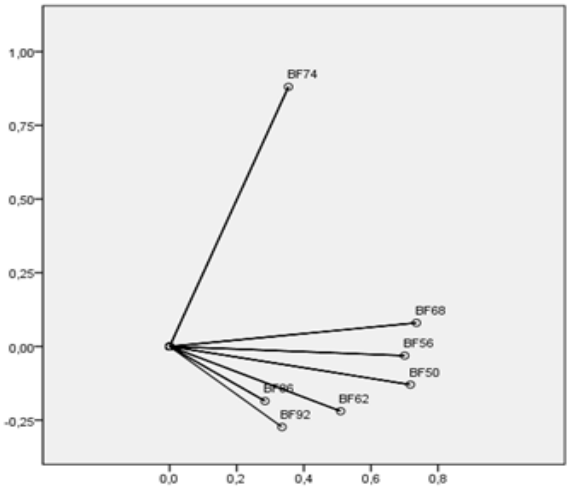

Figure 9 – Items' coordinates for factor Morality

Altruism

The analysis of the altruism latent trait indicates a relatively strongly two-dimensional model with clear item separation. The first component is related to the true factor latent and can explain 27.4% of variance (eigenvalue=2.19), and the second dimension covers about 14.14% of variance (eigenvalue=1.13). In fact, the items 63, 69, 75 and 81 have low saturations in the second dimension, but items 54, 87 and 93 highly saturate this component. Thus, the direction of the second component is placed between a material and social altruism. The second dimension, named *altruism orientation*, distinguishes between subjects oriented to material or financial altruism and those oriented to social altruism, with no material implications.

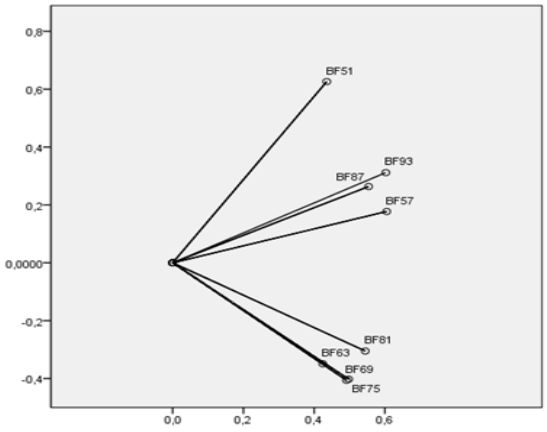

Figure 10 – Items' coordinates for factor Altruism

Cooperation

Previous analysis has suggested removing item 94, but by using the model with all 8 items a two-dimensional construct emerges. The first component is responsible for 27.01% of variance (eigenvalue=2.16) and the second covers 13.44% of variance (eigenvalue=1.07). The main dimension is certainly related to cooperation, but the items 52, 82 and 94, respectively 58 and 70, determine the second. In this case we can identify a guidance axis, named *inter-relationship cooperation*, which distinguishes between competitiveness, exigency and aggressiveness, as opposed to defensive behavior, cooperation, collaboration.

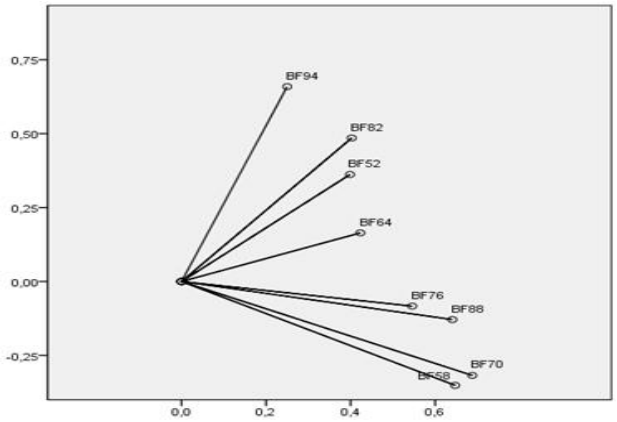

Figure 11 – Items' coordinates for factor Cooperation

Modesty

This is another factor with very low internal consistency, proposed for removal from the analysis. CATPCA analysis noted the presence of two dimensions, the first covering 25.65% of variance (eigenvalue=2.05), and the second 13.55% (eigenvalue=1.08). Item 53 strongly saturates the second dimension in a negative way (.739) and has almost no relevance to the first component. Removing this item could lead to the identification of a *self-image axis* related to modesty. The axis is specified by items 77 and 59 and distinguishes between subjects with a realistic self-image and those which have a very low level of self-image.

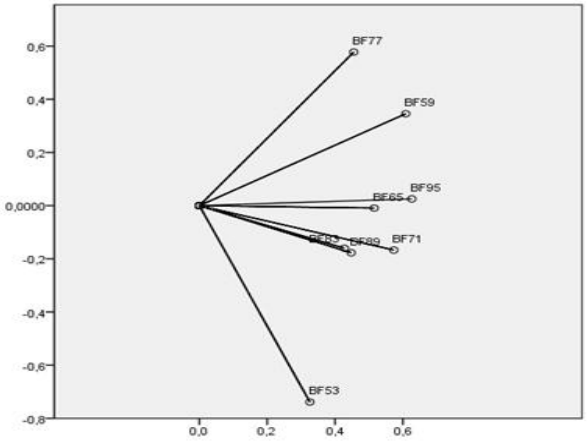

Figure 12 – Items' coordinates for factor Modesty

Sympathy

The latent trait appears to be two-dimensional with the first component explaining 31.40% of variance (eigenvalue=2.51) and the second 12.54% of variance (eigenvalue=1).As one can see, in fact the model is one-dimensional after removing item 84 which saturates the second dimension (.835) very strongly, which in reality does not exist. This item is strongly distanced from all the others, although it refers to the same construct but probably requires desirable responses.

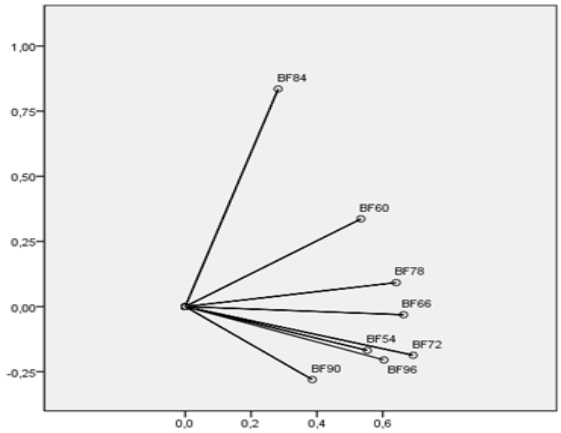

Figure 13 – Items' coordinates for factor Sympathy

Anxiety

The latent trait appears to be one-dimensional which may explain 31.94% of variance (eigenvalue=2.55). A second axis was identified. This cannot be considered a component but can explain about 11.99% of variance (eigenvalue=.959). The two groups of items can be distinguished. The first one positively saturates the second axis and consists of items 97, 103 and 139. The second group represents the main component identified. We can identify the social component of anxiety characterized by the first group. In this case, the axis can be named *social anxiety* and orientates the subjects' anxiety in the direction of social relationships, to professional activities, based on how others can perceive the subject's anxiety or how the subject appreciate others' actions in order to generate anxiety.

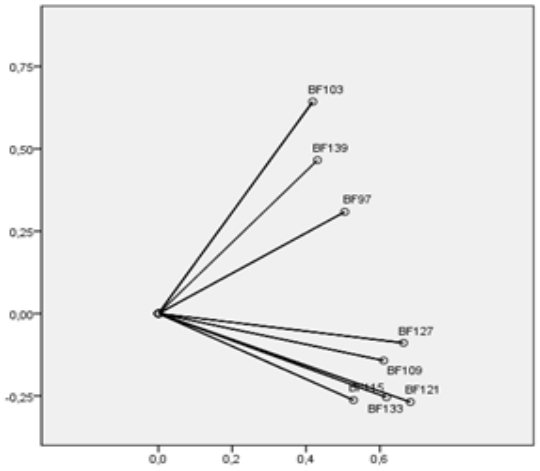

Figure 14 – Items' coordinates for factor Anxiety

Anger

A very good one-dimensional model resulted for latent trait anger, able to explain 41.17% of variance (eigenvalue=3.29). The items are very well grouped around the main component, except item 134, which strongly saturates a second dimension that does not exist (.828). Indeed, this item is not associated with the operational definition of the construct but refers to a kind of attitude in front of social relationships. We can conclude that the latent trait is a one-dimensional 7 item model, and we can consider removing item 134.

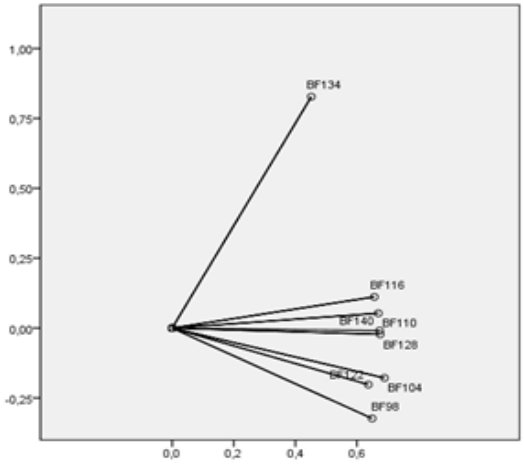

Figure 15 – Items' coordinates for factor Anger

Depression

Depression factor leads to a seemingly two-dimensional model, which consist of 8 items. The first component explains 30.97% of variance (eigenvalue=2.47), and the second can cover 13.82% of variance (eigenvalue=1.1). The two items seem to be problematic in this context. Item 135 has no relevance for the main component but positively saturates and very strongly the second one (.652). Item 117 is related to the main component but also has the most important contribution to the second (.501)
We cannot accept a two-dimensional model for this latent trait. Item 135 is not valid and should be removed, but we can keep item 117 for a one-dimensional model. In fact, suggestion for removal was also made in the process of internal consistency analysis.

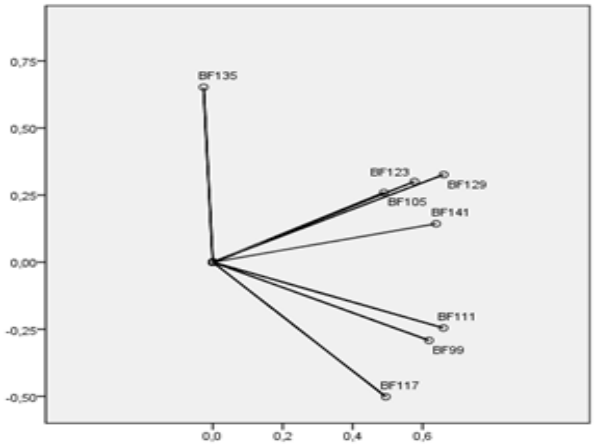

Figure 16 – Items' coordinates for factor Depression

Timidity

A one-dimension model was revealed for the latent trait, which explains 32.52% of variance (eigenvalue=2.6). Apparently, a second axis was identified which covers about 11.45% of variance (eigenvalue=.916).
Only one item should be removed in order to achieve unidimensionality. We are talking about item 112 which is the only item with a high level of saturation in the second dimension (.658). This item does not entirely meet the operational definition of the construct and is not valid. The model is one-dimensional by excluding item 112.

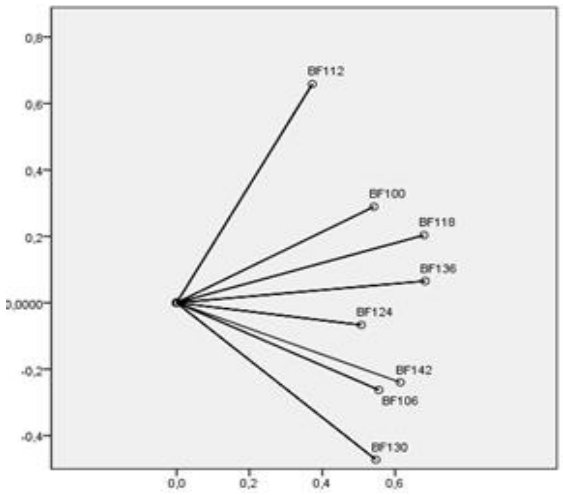

Figure 17 – Items' coordinates for factor Timidity

Immoderation

This is another latent trait with very low internal consistency (.590) and with no suggestions for the removal of items. The analysis reveals a two-dimensional model, able to explain 39.86% of variance (eigenvalue=3.18). The first component explains 26.15% of variance (eigenvalue=2.09) and the second about 13.71% of variance (eigenvalue=1.09). The two components are very ambiguous and cannot be clearly distinguished. The fact is that only items 125, 131 and 137 correspond to the operational definition of the construct. The others are related to irresponsibility, intemperance and frivolity - concepts that are too different compared to construct meaning. We cannot retain this factor for further analysis.

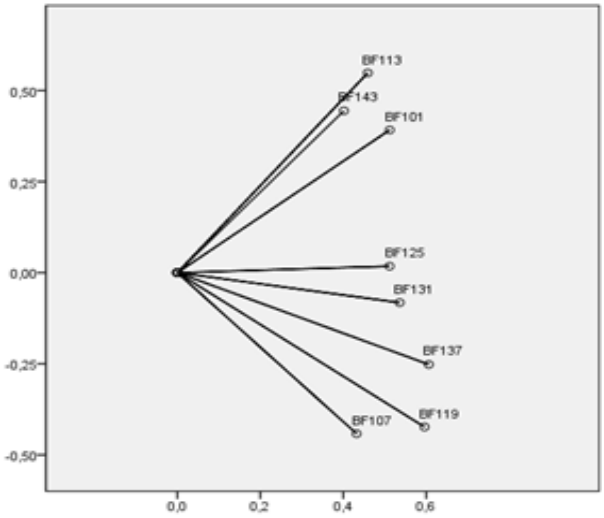

Figure 18 – Items' coordinates for factor Immoderation

Vulnerability

This latent trait proved to have good internal consistency (.76), but CATPCA reveals two components. The main component explains 39.05% of variance (eigenvalue=3.12) and the second just 12.53% of variance (eigenvalue=1). Based on internal consistency and on the first component's eigenvalue we have no reason to assume that the second dimension really exists. As we can see, item 138 saturates the second component (.866) at a very high level and has no relevance for the first component (.266). It is not related to the construct's definition but refers to the working capacity under pressure. This is also the case from item 114, but it saturates the first dimension well enough (.518) to be kept. If we remove the item 138 we can obtain a very a good one-dimensional model, ready to be modeled under IRT.

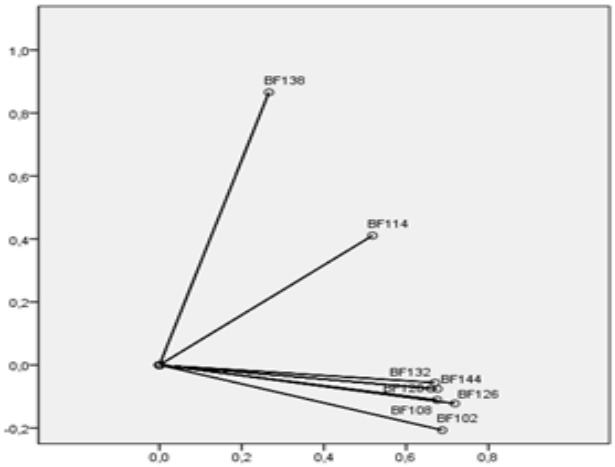

Figure 19 – Items' coordinates for factor Vulnerability

Self-efficacy

Self-efficacy was identified as a poor consistent factor (.681), and the suggestion was to to remove items 157 and 163. The principal component analyzes was not identified as a relevant second dimension. The main component covers 30.59% of variance (eigenvalue=2.44) and the secondary axis only 12.35% of variance (eigenvalue=0.989).

There is no need to eliminate both items as suggested from internal consistency. As we can see, the items are very well grouped around the second axis, except item 157 which highly saturates the second component (.954). Indeed, this item is invalid for this context. It refers rather to

ruthlessness and cynicism rather than self-efficacy. After removal, the model is one-dimensional.

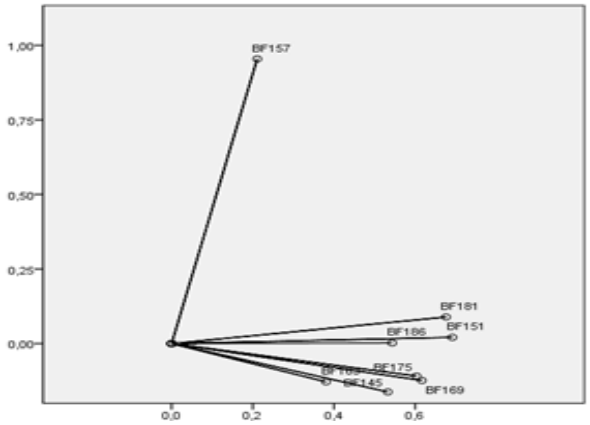

Figure 20 – Items' coordinates for factor Self-efficacy

Orderliness

A number of two components results after the analysis of this latent trait. The main component can explain 31.68% of variance (eigenvalue=2.53), and the second covers 12.8% of variance (eigenvalue=1.02). Items 170(.657) and 182(.622) highly saturate the second dimension, but they are also consistent with the construct. Their apparent problem is that they target accentuated aspects of the orderliness; this can lead to obsessive behavior. Instead of removing these items, we can define an axis named *emphasized behavior* that distinguishes between normal levels of orderliness and trends towards hyper-organization, hyper-planning and obsessive behavior.

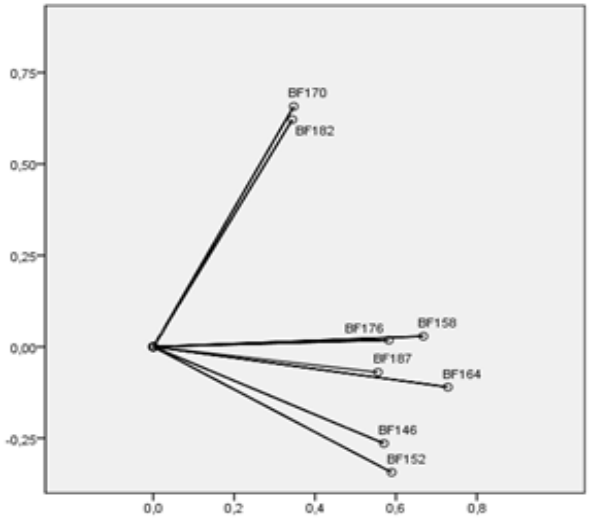

Figure 21 – Items' coordinates for factor Orderliness

Dutifulness

With a low level of internal consistency (.525), CATPCA also demonstrates a one-dimensional model for this factor. The main component is responsible for 24.25% of variance (eigenvalue= 1.94). In addition, a second irrelevant dimension was identified, explaining 12.47% of variance. Items are heavily scattered around the second dimension; to achieve unidimensionality we have to remove three items (147, 153 and 188). All these items are related to the construct, but they are not valid in the socio-economical context of Romania and require desirable responses. Removing three items causes a failure in the informational structure of the model, even if the remaining items are valid and consistent. Therefore, the latent trait cannot be kept and should be eliminated from further analysis.

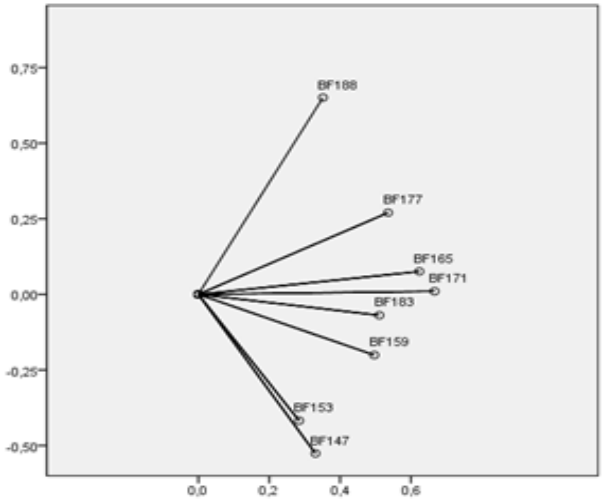

Figure 22 – Items' coordinates for factor Dutifulness

Achievement-striving

The source of the very low internal consistency (.423) is the structure of this latent trait. Apparently, we are in the situation of a certain two-dimensional model with two independent components. The first component covers 21.31% of variance (eigenvalue=1.7) and the second 15.39% of variance (eigenvalue=1.23). This structure can easily be spotted by analyzing the two groups of items. The first group contains items 148, 166 and 184. In fact not all these three items are valid in the context of the factor. The remaining items formed a second group, but in-depth analysis reveals the same problems as in the first group. We can conclude that the latent trait is poorly represented by items so we have to eliminate the factor.

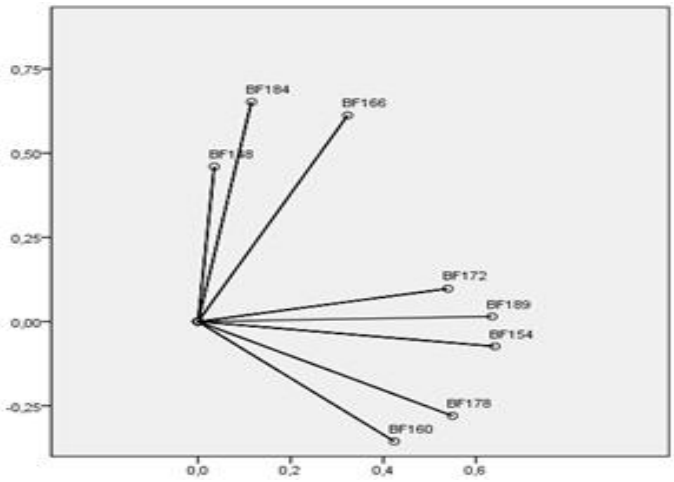

Figure 23 – Items' coordinates for factor Achievement-striving

Self-discipline

Also with low consistency (.586), the items constitute a two-dimensional model. The first component explains 26.49% of variance (eigenvalue=1.12), and the second only 12.83% of variance (eigenvalue=1.02). Item 167 strongly saturates the second component (.745), but the response space is not exhaustive and inadequate for the wording of the item. After removal, items 149 and 155 define a guidance axis for this factor named *effectiveness of self-discipline*. We can distinguish between helpful self-discipline that can lead to overcoming obstacles and achieving the target and the persistence in failure, the behavior of ignorance of failure, saturation and low yield.

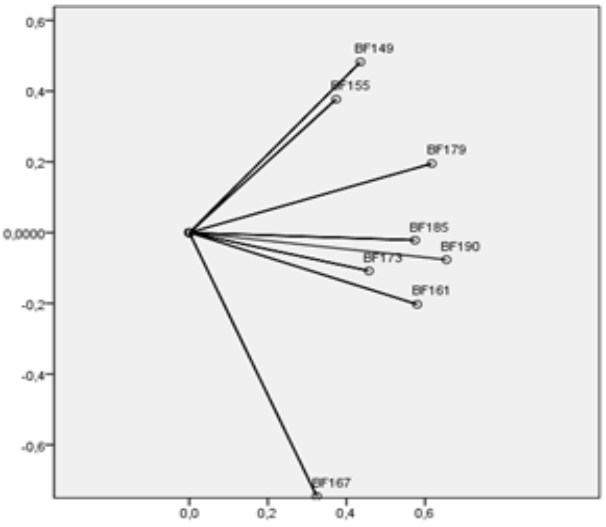

Figure 24 – Items' coordinates for factor Self-discipline

Cautiousness

Cautiousness has good internal consistency (.757), and at first glance it results in a two-dimensional model. The first dimension covers 37.34% of variance (eigenvalue=2.98) and the second 13.47% of variance (eigenvalue=1.07). In fact the model can be accepted as one-dimensional with a secondary axis determined by items 156(.356) and 174(.440) which saturate the second dimension, but they are also related to the first. Clearly, these items determine the financial *cautiousness axis*. They lead to the idea of thriftiness in relation with a person's own money, while the other items suggest a general cautiousness in relation to social and professional activities.

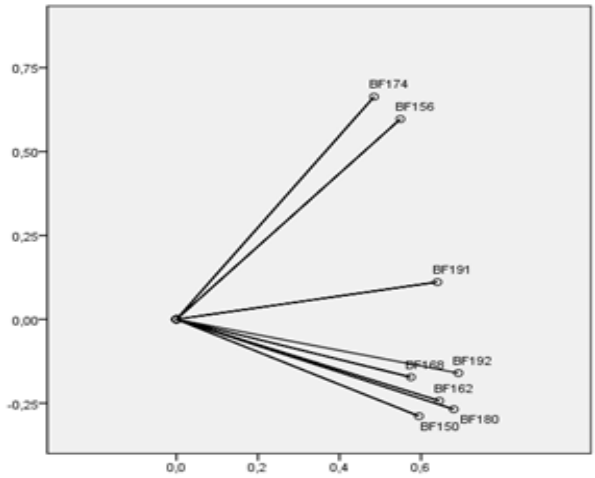

Figure 25 – Items' coordinates for factor Cautiousness

Imagination

For the latent trait two components were extracted. The first component covers 30.41% of variance with an eigenvalue=2.43 and the second component covers 13.26% of variance (eigenvalue=1.0All the items are well grouped reporting to the second dimension except items 217(.788) and 229(.562) which strongly saturate the second dimension. For the latent trait two components were extracted. The first component covers 30.41% of variance with an eigenvalue=2.43 and the second component covers 13.26% of variance (eigenvalue=1.0All the items are well grouped reporting to the second dimension except items 217(.788) and 229(.562) which strongly saturate the second dimension. At first appearance these two items tend to mark a secondary axis but a deeper analysis indicates that item 217 includes

a desirable response, and item 299 is completely non-valid because the wording was not properly elected. In this situation the only option we have is to eliminate these two items and to accept a good one-dimensional model composed by six items. Actually item 217 was proposed for elimination from the time of the phase of internal consistency analysis.

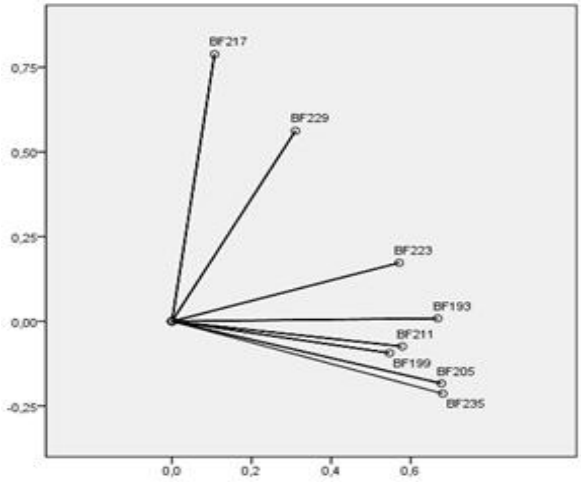

Figure 26 – Items' coordinates for factor Imagination

Artistic interests

The first component identified for this latent trait explains 31.09% of variance (eigenvalue=2.48). There is also a second component explaining 12.78% of variance (eigenvalue=1.02). A two-dimensional axis was identified and composed by a main dimension as well as a secondary axis explaining a total of 43.87% of variance. The item 212(.667) saturates the second dimension negatively and strongly; it is not valid in this context, so we can remove it from further analysis. After removal, the group of items 218, 224 and 230, gives the nature of the secondary axis. They define what we can call the emotional side of artistic interests and opposed by the behavioral side given by the other group.

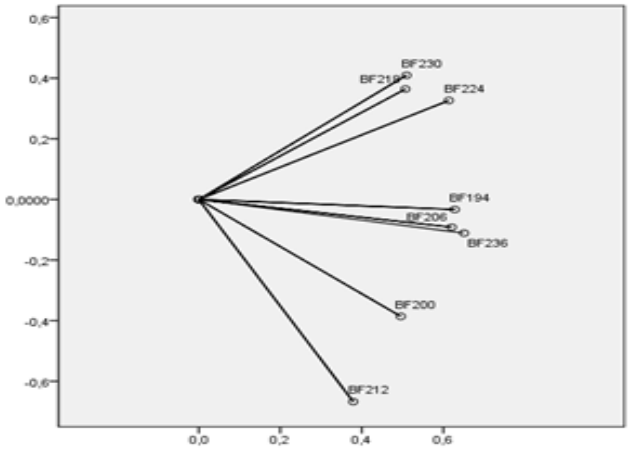

Figure 27 – Items' coordinates for factor Artistic interests

Emotionality

The previous consistency analyses suggested removing a number of two items (201 and 237) to improve internal consistency. Using a complete model of 8 items results a number of two components, first explaining 26.51% of variance (eigenvalue=2.12) and the second covering 15.75% of variance (eigenvalue=1.26). Apparently, there are two problematic items (237(.647) and 201(.626)) that saturate very strong the second component of this factor. In fact, these items refer to the internal way of perceiving the emotions, the subject's image on its own emotionality. The other items refer to the explanatory side of emotions, by which the subject tries to understand what he/she feels and why they feel that way. Given this facts, we can name the second component as *perceptive-rational axis.*

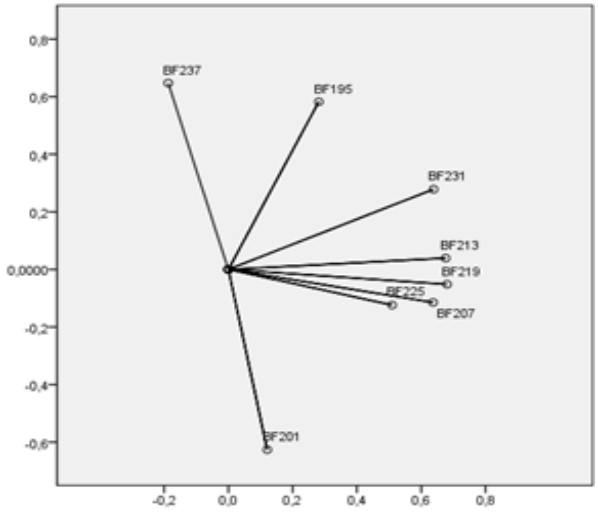

Figure 28 – Items' coordinates for factor Emotionality

Adventurousness

A one-dimensional model resulted in explaining 31.52% of variance (eigenvalue=2.52). A second irrelevant axis was also identified, explaining 12.40% of variance (eigenvalue=.992). The analysis identified two items; one saturated negatively strong from the second axis (item 196(.531)) and the other saturating positively strong from the second axis (item 226(.531)). Both of them are culturally biased and should be eliminated. After removal, the model becomes one-dimensional, ready for IRT analysis.

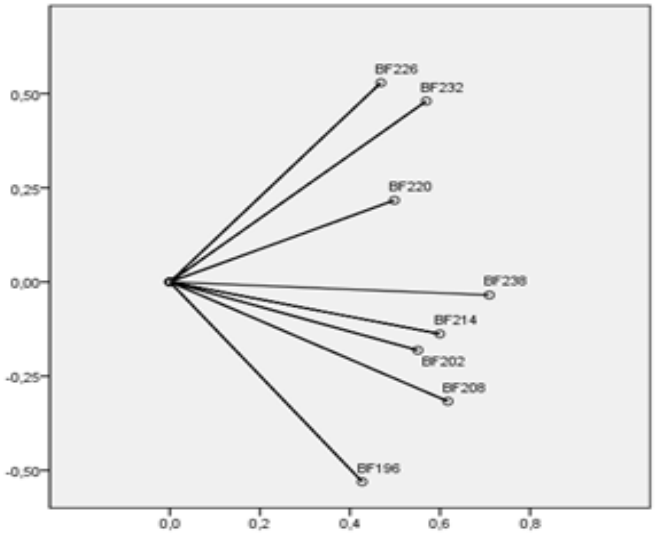

Figure 29 – Items' coordinates for factor Adventurousness

Intellect

The latent trait had very low internal consistency (.486) considering the removal of item 227, but the CATPCA analysis revealed two components. The first component covers 21.96% of variance (eigenvalue=1.75) and the second component explains 15.31% of variance with an eigenvalue of 1.21. Indeed, item 227 should be removed because it has no relevance for this construct, but the other items tend to form two groups. The first group is composed of items 203, 215, 221 and 239 and they saturate the second component positively strong. The remaining items saturate the second component moderately negative. We can identify the nature of the secondary axis named *intellectual orientation*. It distinguishes between internal orientation, defined by concerning the intellectual activities

and social orientation, defined by the ability to expose, to relate to intellectual tasks on a social and professional context.

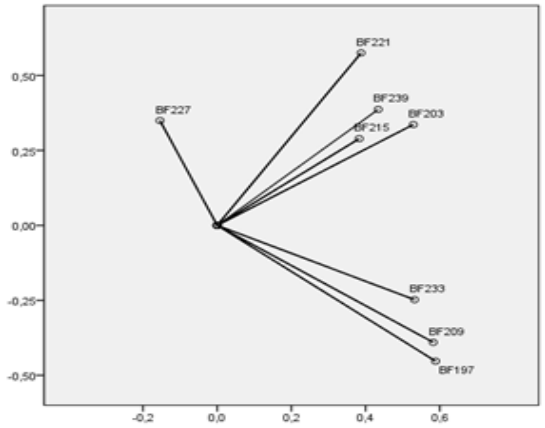

Figure 30 – Items' coordinates for factor Intellect

Liberalism

The final latent trait analyzed is also characterized by low internal consistency (.498) but without suggestion for the items' removal. Principal components analysis also identified two components, first covering 23.03% of variance (eigenvalue=1.84) and the second 13.3% of variance (eigenvalue=1.06). We have no reason to conclude about the existence of the second dimension because the extreme items (216(.710) and 234(.597)) are not valid by a cultural adaptation that require desirable responses. The remaining six items form a one-dimensional model scattered low around the second dimension.

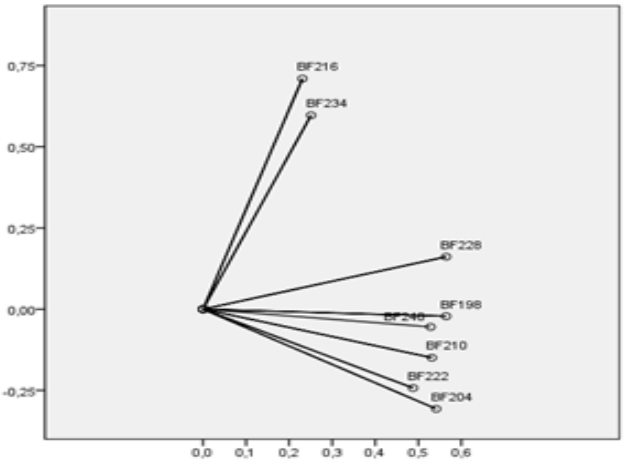

Figure 31 – Items' coordinates for factor Liberalism

Factor (Dimension)	Unimodal	Skewness	Kurtosis	Normality decision
Friendliness m=4,49; s=1,69	Yes Mod = 5	Left skewed Skewness=-0,309; SE=0,036	Platikurtic Kurtosis=-0,558; SE=0,072	No $K\text{-}S_{(4441)}$=0,145; p<0,01
Gregariousness m=4,17; s=1,97	Yes Mod = 5	Left skewed Skewness=-0,183; SE=0,036	Platikurtic Kurtosis=-0,993; SE=0,072	No $K\text{-}S_{(4441)}$=0,13; p<0,01
Assertiveness m=4,08; s=2,15	Yes Mod = 4	Symmetrical Skewness=-0,056; SE=0,036	Platikurtic Kurtosis=-0,896; SE=0,072	No $K\text{-}S_{(4441)}$=0,104; p<0,01
Activity level m=4,75; s=2,01	Yes Mod = 5	Left skewed Skewness=-0,308; SE=0,036	Platikurtic Kurtosis=-0,603; SE=0,072	No $K\text{-}S_{(4441)}$=0,12; p<0,01
Excitement seeking m=4,07; s=2,18	Yes Mod = 5	Symmetrical Skewness=-0,005; SE=0,036	Platikurtic Kurtosis=-0,959; SE=0,072	No $K\text{-}S_{(4441)}$=0,107; p<0,01
Cheerfulness m=4,33; s=2,20	Yes Mod = 6	Left skewed Skewness=-0,118; SE=-0,036	Platikurtic Kurtosis=-0,983; SE=0,072	No $K\text{-}S_{(4441)}$=0,121; p<0,01
EXTROVERSION m=25,89; s=9,14	Yes Mod = 27	Left skewed Skewness=-0,118; SE=0,037	Platikurtic Kurtosis=-0,56; SE=0,073	No $K\text{-}S_{(4441)}$=0,037; p<0,01
Trust m=2,19; s=2,04	Yes Mod = 4	Symmetrical Skewness=0,001; SE=0,036	Platikurtic Kurtosis=-0,806; SE=0,072	No $K\text{-}S_{(4463)}$=0,107; p<0,01
Morality m=4,6; s=1,83	Yes Mod = 6	Left skewed Skewness=-0,371, SE=0,036	Platikurtic Kurtosis=-0,477; SE=0,072	No $K\text{-}S_{(4463)}$=0,146; p<0,01
Altruism m=4,84; s=1,93	Yes Mod = 6	Left skewed Skewness=-0,275; SE=0,036	Platikurtic Kurtosis=-0,579; SE=0,072	No $K\text{-}S_{(4463)}$=0,128; p<0,01
Cooperation m=4,72; s=1,93	Yes Mod = 5	Left skewed Skewness=-0,271; SE=0,036	Platikurtic Kurtosis=-0,586; SE=0,072	No $K\text{-}S_{(4463)}$=0,124; p<0,01
Modesty m=3,92; s=1,93	Yes Mod = 4	Right skewed Skewness=0,11; SE=0,036	Platikurtic Kurtosis=-0,649; SE=0,072	No $K\text{-}S_{(4463)}$=0,113; p<0,01
Sympathy	Yes	Right skewed	Platikurtic	No

m=3,38; s=2,11	Mod = 3	Skewness=0,277; SE=0,036	Kurtosis=-0,793; SE=0,72	K-S$_{(4463)}$=0,126; p<0,01
AGREEABLENESS m=25,65; s=6,89	Yes Mod = 23	Left skewed Skewness=-0,087; SE=0,037	Mezokurtic Kurtosis=0,145; SE=0,073	No K-S$_{(4463)}$=0,041; p<0,01
Anxiety m=2,65; s=2,06	Yes Mod = 1	Right skewed Skewness=0,504; SE=0,036	Platikurtic Kurtosis=-0,621; SE=0,072	No K-S$_{(4431)}$=0,149; p<0,01
Anger m=2,85; s=2,41	Yes Mod = 0	Right skewed Skewness=0,443; SE=0,036	Platikurtic Kurtosis=-0,942; SE=0,072	No K-S$_{(4431)}$=0,151; p<0,01
Depression m=2,42; s=1,80	Yes Mod = 1	Right skewed Skewness=0,686; SE=0,036	Platikurtic Kurtosis=-0,255; SE=0,072)	No K-S$_{(4431)}$=0,174; p<0,01
Timidity m=3,18; s=2,20	Yes Mod = 1	Right skewed Skewness=0,281; SE=0,036	Platikurtic Kurtosis=-0,88; SE=0,072	No K-S$_{(4431)}$=0,129; p<0,01
Immoderation m=3,30; s=1,97	Yes Mod = 3	Right skewed Skewness=0,281; SE=0,036	Platikurtic Kurtosis=-0,628; SE=0,072	No K-S$_{(4431)}$=0,12; p<0,01
Vulnerability m=2,85; s=2,28	Da Mod = 1	Right skewed Skewness=0,583; SE=0,036)	Platikurtic Kurtosis=-0,671; SE=0,072	No K-S$_{(4431)}$=0,164; p<0,01
NEUROTICISM m=17,32; s=8,60	No Mod = 8; 25	Right skewed Skewness=0,189; SE=0,037	Platikurtic Kurtosis=-0,810; SE=0,074).	No K-S$_{(4431)}$=0,08; p<0,01
Self-efficacy m=5,27; 2,00	Yes Mod = 7	Left skewed Skewness=-0,551; SE=0,036	Platikurtic Kurtosis=-0,489; SE=0,072	No K-S$_{(4443)}$=0,159; p<0,01
Orderliness m=4,29; s=2,18	Yes Mod = 5	Left skewed Skewness=-0,227; SE=0,039	Platikurtic Kurtosis=-0,83; SE=0,072	No K-S$_{(4443)}$=0,117; p<0,01
Dutifulness m=5,05; s=1,83	Yes Mod = 6	Left skewed Skewness=-0,506; SE=0,036	Platikurtic Kurtosis=-0,199; SE=0,072	No K-S$_{(4443)}$=0,151; p<0,01
Achievement-striving m=3,55; s=1,67	Yes Mod = 4	Symmetrical Skewness=-0,043; SE=0,036	Platikurtic Kurtosis = -0,505; SE=0,072	No K-S$_{(4443)}$=0,13; p<0,01
Self-discipline m=4,75; s=1,96	Yes Mod = 5	Left skewed Skewness=-	Platikurtic Kurtosis=-	No K-S$_{(4443)}$=0,133;

		0,362; SE=0,036	0,588; SE=0,072	p<0,01
Cautiousness m=5,29; s=2,29	Yes Mod = 8	Left skewed Skewness=-55; SE=0,036	Platikurtic Kurtosis=-0,698; SE=0,072	No $K\text{-}S_{(4443)}$=0,149; p<0,01
CONSCIENTIOUSNESS m=28,2; s=7,25	Yes Mod = 27	Left skewed Skewness=-0,267; SE=0,037	Platikurtic Kurtosis=-0,392; SE=0,073	No $K\text{-}S_{(4443)}$=0,054; p<0,01
Imagination m=2,93; s=1,96	Yes Mod = 2	Right skewed Skewness=0,585; SE=0,036	Platikurtic Kurtosis=-0,344; SE=-0,344	No $K\text{-}S_{(4450)}$=0,164; p<0,01
Artistic interests m=3,58; s=2,13	Yes Mod = 3	Right skewed Skewness=0,176; SE=0,036	Platikurtic Kurtosis=-0,815; SE=0,072	No $K\text{-}S_{(4450)}$=0,112; p<0,01
Emotionality m=5,4; s=1,63	Yes Mod = 6	Left skewed Skewness=-0,669; SE=0,039	Mezokurtic Kurtosis=0,014; SE=0,072	No $K\text{-}S_{(4450)}$=0,186; p<0,01
Adventurousness m=4,19; s=2,19	Yes Mod = 5	Symmetrical Skewness=-0,063; SE=0,036	Platikurtic Kurtosis=-0,855; SE=0,072	No $K\text{-}S_{(4450)}$=0,10; p<0,01
Intellect m=3,16; s=1,60	Yes Mod = 2	Right skewed Skewness=0,366; SE=0,036	Platikurtic Kurtosis=-0,299; SE=0,072	No $K\text{-}S_{(4450)}$=0,144; p<0,01
Liberalism m=3,11; s=1,79	Yes Mod = 2	Right skewed Skewness=0,366; SE=0,036	Platikurtic Kurtosis=-0,326; SE=0,072	No $K\text{-}S_{(4450)}$=0,136; p<0,01
OPENESS m=22,38; s=6,46	Yes Mod = 22	Right skewed Skewness=0,296; SE=0,037	Leptokurtic Kurtosis=0,413; SE=0,073	No $K\text{-}S_{(4450)}$=0,055; p<0,01

Table 1. Scores distributions for BigFive Plus factors and dimensions. Normality analysis

Factor	Alpha Cronbach	Inverted items	Item proposed for removal	Total items	Factor proposed to be kept
Friendliness	0,688 (0,690)	37	-	8	Yes
Gregariousness	0,750 (0,750)	20	-	8	Yes
Assertiveness	0,675 (0,674)	-	-	8	Yes
Activity level	0,634 (0,634)	-	-	8	Yes
Excitement seeking	0,699 (0,697)	-	-	8	Yes
Cheerfulness	0,703 (0,701)	-	-	8	Yes
Trust	0,637 (0,636)	-	-	8	Yes
Morality	0,537 (0,540)	80	-	8	No
Altruism	0,615 (0,616)	-	-	8	Yes
Cooperation	0,604 (0,604)	-	94	7	Yes
Modesty	0,572 (0,574)	-	-	8	No
Sympathy	0,669 (0,671)	-	-	8	Yes
Anxiety	0,684 (0,687)	-	-	8	Yes
Anger	0,793 (0,793)	-	-	8	Yes
Depression	0,688 (0,691)	-	135	7	Yes
Timidity	0,696 (0,695)	-	-	8	Yes
Immoderation	0,590 (0,591)	-	-	8	No
Vulnerability	0,760 (0,764)	-	-	8	Yes
Self-efficacy	0,681 (0,681)	-	157, 163	6	Yes
Orderliness	0,676 (0,677)	-	-	8	Yes
Dutifulness	0,525 (0,530)	-	-	8	No
Achievement-striving	0,423 (0,423)	-	-	8	No
Self-discipline	0,586 (0,588)	-	-	8	No
Cautiousness	0,757 (0,757)	-	-	8	Yes
Imagination	0,669 (0,673)	-	217	7	Yes
Artistic interests	0,679 (0,676)	-	-	8	Yes
Emotionality	0,600 (0,612)	-	201, 237	6	Yes
Adventurousness	0,683 (0,683)	-	-	8	Yes
Intellect	0,486 (0,493)	-	227	7	No
Liberalism	0,498 (0,503)	-	-	8	No

Table 2. Scale consistency for BigFive Plus factors

V. Discussion

This study of the BigFive Plus Inventory's internal structure in order to prepare the items for an IRT model represents a complex process initiated by the univariate analysis of distributions, continued with internal consistence analysis and finalized with CATPCA. Some of the suggestions related to the items' removal in the internal consistency analysis which were confirmed in CATPCA; a variable number of items were removed from each latent trait to achieve either a one-dimensional model or a dimensional-axial structure. All these adjustments of the classic version of the test have been imposed due to demands of the item response models and not because of structural deficiencies of the classical test form.

Three factors were completely removed because very low consistency or too many items' elimination requirements. By CATPCA we identified distances that the items are located in relation to dimensions, and we found the reason for some inconsistencies.

This current study provided new information concerning the internal structure of the BigFive Plus inventory. A Romanian version of the BigFive model questionnaire, developed by Constantin et al. (2008), allowed for a refinement of the latent trait structure. Now we have to consider that the remaining items are purely consistent, the diagnostic power of the test is increasing, and all the items are prepared for the next stage which is the adaptation for an item response model.

Further studies should investigate the item's unidimensionality using Stout's test of essential unidimensionality and NOHARM techniques, as well as the item calibration for an IRT model. Despite the CATPCA results and factor elimination, we will keep those factors in unidimensionality investigation; their removal will be done when a true one-dimensional model fails to achieve.

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