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Multidimensional micro-level competitiveness measurement: a SEM-based approach

Quaderni di Dipartimento

Serie Ricerche 2013, n. 6
ISSN 1973-9346

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UNIVERSITÀ DI BOLOGNA

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MULTIDIMENSIONAL MICRO-LEVEL COMPETITIVENESS MEASUREMENT: A SEM-BASED APPROACH

1 Introduction

The concept of competitiveness, for a long time considered as strictly connected to economic and financial performances, evolved, above all in recent years, toward new, wider interpretations disclosing its multidimensional nature.

The diffusion of new world views, implying changes in the theoretical approaches to the analysis of those phenomena governing the growth and development processes, both at a macro and micro level, drove different disciplines toward the consideration of the relevance of the so-called intangible aspects in defining and characterizing concepts that, until that moment, were only considered from a strictly monetary point of view.

The shift to a multidimensional view of competitiveness, has excited an intense debate involving theoretical reflections on the features characterizing the competitive phenomenon, as well as methodological considerations on its assessment and measurement.

In analyzing competitiveness, the growing consensus in favour of including other dimensions, beyond monetary indicators, is bringing to an increase in the number of empirical studies aiming at assessing and measuring the phenomenon through the use of multidimensional measures. Such a framework is mainly used in macro-level competitiveness analysis approaches. Several studies have in fact been conducted with the aim of identifying composite measures of competitiveness, by starting from a wide interpretation of the phenomenon itself. Micro-level studies, continue instead to identify competitiveness with economic performances and to study it by assessing relations with its separately taken into account, tangible and intangible, determinants. In broader terms, micro-level approaches identify competitiveness with profitability measures, only recognizing multidimensionality at the level of factors affecting and determining it.

In this perspective, the idea is to borrow the macro-level interpretation of competitiveness for assessing the phenomenon from a micro-level point of view. We will thus give micro-level competitiveness a huge connotation, able to include and describe several aspect of the phenomenon under investigation.

This imply a new view of competitiveness based on its multidimensional nature, as well as the analysis of both the economic and management theories for the understanding of the main features to be taken into account for an exhaustive analysis of all underlined dimensions under investigation.

More specifically, the present paper has the objective of going in depth with the study of tangible and intangible aspects characterizing multidimensional competitive phenomena by assuming a micro-level point of view, and measuring competitiveness through a model-based approach to the construction of composite indicators.

We propose a Structural Equation Models-based approach to the construction of composite indicators, as it offers methodological tools that may help to overcome controversial questions related to the computation of multidimensional measures. We also present an empirical application to the Italian case based on a large sample of Italian small and medium enterprises in 2008.

Specifically, we introduce a non-parametric approach to Structural Equation Models since it can be helpful in analyzing the micro-level competitiveness framework, for a manifold order of reasons. First, Non-parametric Structural Equation Models techniques allow to analyze multidimensional and heterogeneous phenomena, whose study involves several latent aspects to be taken into account (without making any assumption on data distribution), by considering and reducing their inner complexity through a dynamic approach allowing to assess the causality networks among the different dimensions explaining the phenomenon and the phenomenon itself, as well as to understand whether and to what extent each dimension contribute in determining it. Such a technique gives us the chance to conceptualize competitiveness as a huge, latent and heterogeneous phenomenon, hypothesized to be determined by several latent dimensions, in their turn characterized by an inner complexity and multidimensionality that Structural Equation Models allow to take into account. Second, in a composite measures computation perspective Structural Equation Models give the chance to aggregate competitiveness dimensions by endogenously individuating two kinds of optimal weights, those reflecting the internal structure of each competitiveness dimension and the ones measuring the contribution of each dimension in determining the overall micro-level competitiveness measure. It will be therefore possible to simultaneously consider the elements influencing micro-level competitiveness and to test not only their significance, but also to what extent they determine it.

In summary, two novelty elements are introduced. The former is strictly related to the phenomenon under investigation: we study micro-level competitiveness by considering its multidimensional characterization. In our perspective competitiveness is not only related to the micro-level economic performance; a huge connotation that would be able to include several aspect of the phenomenon is here taken into account. To this end we conceptualized competitiveness as a latent, multidimensional construct to be estimated by taking into account its several determinant. Five dimensions are proposed to include influences due to environment and market competitors, innovation, economic performance, workforce composition and gender equality policies. The latter novelty element is the SEM PLS-based composite choice that allowed us to simultaneously consider the elements influencing micro-level competitiveness and to test their significance, and to what extent they determine it.

2 Model-based PLS Composite Measures

The debate on the statistical foundation of composite indicators has been characterized, above all in recent years, by increasing attention toward the methods to be implemented in order to overcome the limits characterizing the composite measures construction processes.

It is undoubted that the challenges of constructing composite indicators for describing multidimensional phenomena are a very discussed theme, whose most controversial aspects can be identified in the subjectivity lying at the base of the choice of the key variables composing the final indicator, the arbitrariness of the weighting and aggregation processes, and the difficulty in the interpretation of movements in the composite measure.

In our view, the Partial Least Squares-Path Modeling (Wold, 1975) methodology within the Structural Equation Model approach is a suitable tool for the construction of model-based composite indicators as it is a distribution free approach, it does not require any assumption both on the sample size and the measurement scale, thus allowing to handle with several kind of data structures. Its great flexibility also allows to take into account the existence of non-linear relations among variables.

We argue that, from a composite indicator construction perspective, Structural Equation Model techniques may be helpful for a twofold order of reasons: multidimensional and heterogeneous phenomena, whose study and understanding involves several latent aspects to be taken into account, can be investigated by considering and reducing their inner complexity trough a dynamic approach allowing to assess the causality networks among the different dimensions explaining the phenomenon and the phenomenon itself, as well as to understand whether and to what extent each dimension contribute in determining it.

In this perspective several aspects of a multidimensional phenomenon can be conceptually split in different blocks of indicators, each block representing a latent feature of the analyzed phenomenon. It is possible to aggregate indicators by simultaneously taking into account both the variables membership to latent blocks and the causal relationships among blocks; and to obtain two kind of weights: the former measuring the impact of each observed variable on the latent block it is linked to and the latter measuring the impact of each block on the one representing the phenomenon to be measured. These two levels of weights can help to understand which are the most important observed variables defining each latent block and which block is the main driver of the overall composite indicator.

Going in more in depth, the construction of a model-based indicator though a Structural Equation Model approach involves three fundamental phases:

- model specification,
- model estimation,
- model evaluation.

The model specification phase. The model specification process is characterized by the theoretical choice of both the latent dimensions determining the phenomenon under investigation and the observed variable to be used in order to measure them, as well as by the specification of the causal relationships characterizing the phenomenon structure.

The model specification procedure consist in the definition of two conceptually different models: a measurement (or outer) model specifies the relationship of the observed variables with their corresponding (latent) constructs; a structural (or inner) model then specifies the hypothesized causal relationships among latent constructs. The two sub models' equations respectively given by:

$\boldsymbol{\xi}_{(m,1)}=\mathbf{B}_{(m,m)}\cdot\boldsymbol{\xi}_{(m,1)}+\boldsymbol{\tau}_{(m,1)}$;

$\mathbf{x}_{(p,1)}=\boldsymbol{\Lambda}_{(p,m)}\cdot\boldsymbol{\xi}_{(m,1)}+\boldsymbol{\delta}_{(p,1)}$

where the subscripts *m* and *p* represent the number of, respectively, the latent (LV) and the manifest variables (MV) in the model, while ξ, x, B, Λ, τ and δ indicate LV and MV vectors, the path coefficients linking the LV, the factor loading linking the MV to the LV, and the errors terms of the model.

The model estimation phase. The parameters estimation is based on a double approximation of the LVs ξ_j (with j=1, ...,m). The outer procedure consist in determining the latent variable scores as the product of the block of MVs X_j and the outer weights w_j (which represent the estimation of measurement coefficients, Λ). The internal estimate z_j of the latent variables is instead obtained as the product of the external estimation of ξ_j, y_j, and the inner weights e_j.

In a PLS-PM framework three different directions of causation between the observed variables and the latent ones can be hypothesized, respectively called reflective scheme, formative scheme and MIMIC mode.

In the reflective scheme the set of manifest variables linked to a latent one is assumed to measure a unique underlying concept. Each manifest measure reflects the corresponding latent construct and plays a role of endogenous variable; it is assumed to be generated as a linear function of its latent variable and the residual term representing the imprecision in the measurement process.

If a formative scheme is chosen, the latent variable is supposed to be generated by its own manifest variable. Each manifest variable represents a different dimension and captures different aspects of the underlying concept. The latent variable is obtained as a linear combination of its own manifest variables plus a residual term representing the fraction of the corresponding latent variable not accounted for by the block of the manifest variables.

The MIMIC scheme is a mixture of both the reflective and formative ones.

According with the relationship among MVs and LVs, outer weights are computed as:

$w_j = X_j' z_j$ for Mode A (reflective relationship),

$w_j = (X_j' X_j)^{-1} X_j' z_j$ for Mode B (formative relationship).

Once the latent variable scores have been estimated by means of the outer estimation procedure, the internal estimate procedure starts. The inner estimate z_j of the standardized latent variables is defined as the sign of the correlation between the estimated y_j and the y_i's connected with it_j, with $i \neq j$[1]. That is, each latent variable is estimated by taking into account its links with the other adjacent latent variables.

After convergence, once the latent variable scores have been estimated, the structural coefficients, describing the causal relationships inside the model, are estimated through an OLS multiple regression among the connected latent variables[2].

Briefly, PLS-PM estimation approach aims at the estimation of the latent variables in such a way that they are the most correlated with one another and the most representative of each corresponding block of manifest variables. It attempts to obtain the best weight estimates for each block of indicators corresponding to each latent variable. The resulting component score of each latent variable, based on the estimated indicator weights, maximizes explained variance for dependent variables.

The model estimation phase allows not only the computation of the composite indicator scores, but also the measurement of the latent variables representing different dimensions characterizing the phenomenon of interest; moreover the aggregation of such measures

[1] This estimation procedure is called centroid scheme. However, other internal weighting schemes exist: the factorial and the path weighting ones. If a factorial scheme is chosen, the inner weights are computed as the correlation between adjacent latent variables. In the path weighting scheme is instead possible to take into account the role of the latent variable in the model (endogenous or exogenous) by differently estimating the inner weights (simple correlation coefficients or multiple regression coefficients).

[2] As usual, the use of OLS multiple regression could be disturbed in presence of strong multicollinearity between the estimated latent variables. In such a case, PLS regression may be used instead.

involves a system of weights based on the estimates of the causal relationships determining the phenomenon structure, thus allowing to understand which are the main drivers of the phenomenon itself.

The model validation phase. The model evaluation process is developed in a PLS-PM framework and focuses on the model prediction capability, being a variance-based approach strongly oriented to the latent variables prediction.

A model can be validated at three levels: the quality of the measurement model, the quality of the structural model and of each structural regression equation.

The Communality index measures the quality of the measurement model for each block, that is how much of the manifest variable variability in the j-th block is explained by its own latent variable.

As far as the quality index for the structural model is concerned, it is possible to link the prediction performance of the measurement model to the structural one by means of the *redundancy* index computed for the j-th endogenous block. The redundancy index measures the portion of variability of the manifest variables connected to the j-th endogenous latent variable explained by the latent variables directly connected to the block itself.

Moreover, a global criterion of goodness of fit has been proposed by Tenenhaus, Amato et al. (2004): the GoF index. It has been developed in order to take into account the model performance in both the measurement and the structural model and thus provide a single measure for the overall prediction performance of the model. The GoF index is calculated as the geometric mean of the *average communality* index and the average R^2 value.

The disadvantage of the above presented indexes is that they are descriptive and there is no inference-based threshold to judge the statistical significance of their values. It is nevertheless possible to estimate the significance of the model parameters trough cross-validation methods like jack-knife and bootstrap (Efron & Tibshirani, 1993). Moreover, it is possible to build a cross-validated version of all the quality indexes (i.e. of the *communality* index, of the *redundancy* index, and of the GoF index) by means of a *blindfolding* procedure (Chin, 1998; Lohmöller, 1989).

In summary, the non-parametric approach to Structural Equation Models gives the chance to overcome some limits characterizing the traditional composite indicators construction methods: the choice of the key indicators, even if grounded on theory-based issues, can be confirmed or not once the parameter estimation phase is concluded; that is, the parameter estimation can reveal the non-significance of some indicator in determining the estimates of the latent constructs they are linked to. In such cases it is possible to reformulate the starting hypotheses by removing or modifying the key indicators and to re-test their validity. Moreover the double system of optimum weights is not arbitrarily chosen, but is the result of an estimation and validation process guarantying against subjective solutions, and giving the chance to identify the most important elements determining the composite indicator.

3 The Proposed Multidimensional Competitiveness Model

Assuming a new micro-multidimensional oriented perspective in measuring competitiveness implies the identification of the main aspects (dimensions) to be taken into account for the comprehensive description of the phenomenon itself and the most suitable indicators to be used in order to measure each of these aspects.

A key role is therefore played by the theoretical framework lying at the base of the study, as the process of variable selection is fundamental for the coherence and validity of the whole empirical research.

Our starting point has been the choice of a definition of the concept of competitiveness able to disclose its multidimensional nature. Defining the concept of competitiveness is itself a research problem: in spite of the increasing attention around the phenomenon, there is not a clear, univocal and widely accepted interpretation of competitiveness. Among the several, different definition found in literature, the one formulated by the Research Centre for Competitiveness (University of Budapest) is, in our opinion, the most exhaustive one: micro-level competitiveness is defined as "the company's ability to permanently offer consumers products and services, which are in compliance with the standards of social responsibility, and for which they are willing to pay more than for the competitors' products, ensuring profitable conditions for the company.

Condition of this competitiveness is that the company should be able to detect changes in the environment and within the company, by performing permanent better market competition criteria compared to the competitors".

The above definition takes into account some competitiveness features whose consideration seems to be unavoidable for a complete understanding of the conceptual, theoretical and practical underpinnings of competitiveness.

In particular, it is possible to individuate three different aspects that, at the enterprise level, are fundamental for assessing the competitive performance: it is immediately clear that at the base of the definition lies the concept of competitiveness as the ability of assuring the efficiency in the utilization of resources and the results of competitive performance in terms of growth of output, productivity, and profitability, that is, to attain the basic economic and financial objectives.

A firm is thus competitive if it can produce products or services of superior quality or lower costs than its domestic and international competitors. It is, therefore, synonymous with a firm's long-run profit performance and its ability to compensate its employees and provide superior returns to its owners. In the narrow sense, such measures of competitiveness at the firm level comprise indicators of financial performance, such as the development of sales, profits, and costs, as well as stock performance.

The importance of the economic and financial side of competitiveness represent the substratum of most of the economic theories on competitive advantage, that, above all in the past, was mainly grounded in outstanding products, creative marketing and aggressive pricing.

However, by reading the definition under analysis, it is easy to understand that competitiveness is not only a question of economic or financial performance, but it is to a large extent strictly related to the enterprise culture, the management ability and the human resources of the company to adapt to changing conditions, by the ability to influence the enterprise environment, innovate, develop or explore new technologies and markets.

This is mainly due to the fact that in recent years companies have to cope with a radical change in their approach to competitiveness: no more economic and financial elements but also the rules of the rising information society have to be taken into account.

In this contest the importance of intangible assets and the resource-based view of firms has to be underlined as they determine the firm capacity to renew competence and processes in order to match up with changing environment.

The third element emerging from the definition is the one related to the concept of Corporate Social Responsibility that can play a key role in contributing to sustainable development while enhancing firms innovative potential and competitiveness. To take into consideration the principles of social responsibility while attempting to individuate a comprehensive competitiveness structure, means to focus on how enterprises do their work: how they treat their employees, how they produce goods, how they market them, and so on; that is, to emphasize not so much what enterprises do with their profit, but how they make that profit.

In this perspective, our proposal is to introduce five competitiveness dimensions, as presented in Table 1.

The variables required for the analysis have been assigned to the respective competitiveness dimensions on the basis of the most important aspect emerged from the economic and management literature analysis. In particular, the Corporate Social Responsibility theory represents the theoretical substratum at the base of the choice of variables measuring the firms proactivity in implementing environmental policies (Galdeano-Gomez *et al.* 2008; Nakao *et al.* 2007; Wahba, 2008; Aragón-Correa & Rubio-López, 2007; Porter *et al.* 2007).

Our hypothesis is that higher levels of environmental proactivity allows firms to gain competitive advantages due to differentiation process rising from the customer perception that green products are more valuable, and to the cost reduction deriving from the adoption of practices that improve the production process[3], by finally increasing firms efficiency and by reducing input and waste disposal costs.

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[3] In this contest the environmental Corporate Social Responsibility theory join together with the Resources Based View one as proactive environmental activities require changes in routines and operation, coordination of human and technical skill in order to be able to reduce environmental impacts by simultaneously maintain or increase the competitiveness

Table 1 *- Competitiveness Dimensions*

DIMENSION	MAIN FEATURES
ECONOMIC	Provides information on the economic status of firms. It should include measures of firms economic performance, profitability, investment policy, openness, and so on. In most of the analyzed literature it generally coincide with competitiveness itself.
LABOUR	Provides information on the workforce composition, on the contractual typologies and on the firms skills level.
GENDER	Provides information on the gender equality measures implemented by firms.
ENVIRONMENT	Provides information on the environmental management strategies implemented by firms, taking into account both end of pipe and integrated policies.
INNOVATION	Provides information on the innovative ability of firms, by including measures of intangible assets considered fundamental in determining the firms ability to innovate

Three environmental variables[4] have been chosen. Specifically, we decided to distinguish between two different types of environmental innovations and investments that mitigate the environmental burden of production: integrated and end-of-pipe investments. Integrated investments reduce resources use and/or pollution at the source by using fair technologies and production methods, whereas end-of-pipe

of firms. Environmental policies encourage the development of new tangible and intangible firm resources.

[4] Data on end-of-pipe, integrate and current investments were disposable for four categories: water, air, waste and other. For the porpoises of the present study they were aggregated by investment typology by obtaining, in this way, three environmental variables.

technologies curb pollution emissions by implementing add-on measures. This is the reason why integrated investments are frequently seen as being superior to end-of-pipe technologies for both environmental and economic reasons.

The Corporate Social Responsibility theory also furnished us the theoretical basis for the choice of variables measuring the gender equality firms engagement (Hutching & Thomas, 2005; Kirton & Greene, 2005; World Bank, 2002; Maddock, 1995).

We argue that the implementation of gender equality policies should foster firms competitive advantages from a twofold point of view: gender equality enhance the likelihood to select workforce from a broader talent pool, by improving human resources features and therefore promoting overall performance in the workplace; moreover it helps firms to improve their positive image in front of responsible consumers and other external market agents, thus enforcing the relational capital of firms. It is easy to understand that the topic of gender equality is strictly related to the theories on firm resources and human capital because favoring gender equality helps to contribute to a of long-term value creation firm strategy, by generating and strengthening human, relational and organizational capital.

Three gender equality variables have been chosen: the number of employed women, calculated as a percentage with respect to the number of employed men, the difference (in percentage) between women and men wages, representing the gender pay gap measure, generally considerate one of the most important gender discrimination variable, and the number of women holding executive and managerial position for testing the hypothesis that firms led or managed by women are more competitive than male managed firms.

Although the introduction of the environment and gender dimensions in the micro-level competitiveness model has been justified and explicated by referring to the Corporate Social Responsibility principles, we prefer to separately treat them with the aim of understanding and evaluating the contribution of each of them in determining micro-level competitiveness levels.

The selection of variables measuring the human resources and organizational side of firms has been accomplished by taking into account the Dynamic Resources Based View theory (Helfat, 2000; Helfat

& Peteraf, 2003; Teece, Pisano & Shuen, 1997; Zollo & Winter, 2002). Firms investments in human resources are one of the most important elements determining firms competitive advantages. Firms that seek to optimize their workforce through comprehensive human capital development programs not only achieve business goals but also a long term survival and sustainability. To accomplish this undertaking, firms need to invest resources to ensure that employees have the knowledge, skills, and competencies they need to work effectively in a rapidly changing and complex environment. It is fundamental to actuate firm processes that relate to training, education and other professional initiatives in order to increase the levels of knowledge, skills, and abilities of employees, which lead to the employee's satisfaction and performance, and therefore to a better firm performance. The implementation of strategies for improving workforce productivity as a driver for higher firm competitiveness levels is an important focus also from the organizational point of view: the fair workforce management is fundamental in determining employees job satisfaction and therefore better working performances.

Six variables have been chosen with the aim to measure firms human and organizational intangible resources management: the average annual wages per employee, the workforce training investments, and four variables on the employment contractual typology (project workers, temporary workers, part time employees and fixed term employees) for measuring the workers mobility and therefore the organizational side of firms and their ability to cope with the ever-changing external environment.

An unavoidable aspect for the analysis of competitiveness is the importance of intangible assets strictly related to the knowledge and innovation creation and accumulation processes. For the detection of the variables to be used in order to measure the above mentioned micro-level competitiveness aspect the Resources Based View theory (Barney, 1991; Lippman & Rumelt, 1982; Peteraf, 1993; Corrado *et al.* 2005) has been taken into consideration, with special attention to the role of intangible assets determining innovation.

The capacity to improve skills, innovate, develop and explore new technologies determine to a large extent the competitive advantages of firms. The deployment of intellectual capital and intangible assets is a key strategic weapon for realizing new and better products and processes innovations: the process of knowledge accumulation mainly realized through the investments in the field of research and development and in information and communication technology brings to a more skilled working environment, resulting in a greater number of innovative processes, thus determining micro-level competitive advantages.

The variables chosen in order to measure the innovative potential of firms are: investments in research and development; advertising expenditure; investments in intellectual property rights (patenting), and software acquisition.

In spite of the huge amount of studies on the intangible side of competitiveness and in spite of the undoubted relevance that continue to be attributed to it, the tangible elements of competitiveness are still recognized to be substantially determinant.

This is the reason why we introduced some variables measuring the economic and financial performance of firms.

Differently from most of the micro-economic studies on competitiveness, we made the decision to use economic performance variables as input factors.

Generally, economic performance measures are treated as output variables explaining the firm competitiveness level: competitiveness coincides with economic performance indicators that, therefore, play the role of dependent variables in most of the competitiveness models.

We instead decided to use them as an input factor, by hypothesizing that economic performance indicators concur, together with the previous listed variables, to the determination of the firms competitiveness level.

The economic and financial performance variable chosen in the present study are: Value Added per employee, EBITDA on value added, return on sales, export on turnover, and depreciation rate.

With the aim of building a micro-level competitiveness indicator by means of Structural Equation Model-based approach we proceeded by specifying the theoretical model explaining the causal relationships characterizing the micro-level competitiveness structure according to the five (latent) hypothesized competitiveness dimensions.

Each dimension is inferred from a series of observable variables, describing their multidimensional nature. Once these determinants of competitiveness representing heterogeneous latent constructs have been measured, they are used as indicators of the micro-level overall competitiveness.

A hierarchical second order model has been specified; the first order level being composed of five competitiveness dimensions and the second one by the overall competitiveness latent variable.

Formative relationships have been hypothesized to exist among the observed variables and the corresponding competitiveness dimensions: each observed variable composing the competitiveness dimensions is expression of a different feature of the corresponding pillar and each competitiveness pillar is a linear combination of its own measured variables. The first order analysis thus provide the weight relation inside each competitiveness pillar, in this way it is possible to understand whether and to what extent each observed variable contribute in determining the competitiveness dimension it is linked to. The second order level of the model, represented by the overall competitiveness variable, has been hypothesized to be directly influenced by each dimension composing the lower order level. The above mentioned dimensions play the role of observed variables, determining, in a formative framework, the micro-level competitiveness measure.

We then proceed by testing the hypothesis that all the specified dimensions have a positive impact on the latent construct representing multidimensional competitiveness indicator, and by assessing the weight relation between each competitiveness aspect and competitiveness itself with the aim of understanding which are the most relevant elements determining micro-competitiveness levels.

In doing this, the Partial Least Square (PLS) non-parametric approach has been used in order to estimate the model parameters since it is a distribution free method, thus enabling to implement the analysis on non-normal and highly skewed data, and because it does not require any assumption both on the sample size and the measurement scale.

4 An Empirical Application

The database used in order to conduct the present study is the result of the link of two data sources: the ISTAT survey on Italian Small and Medium Enterprises and the ISTAT statistical archive of Italian active enterprises (known as ASIA register).

The ISTAT survey on Italian Small and Medium Enterprises furnishes information on Italian active firms with less than 100 employee. It contains variables providing information on the firms balance sheet (economic and financial data), on the workforce composition (including detailed information on personnel costs and expenditure), on fixed and intangible investments as well as on firms environmental practices. The data of the answering enterprises have been revised, submitted both to consistency and compatibility checks and to partial missing data and outliers treatment[5].

The ISTAT statistical archive of Italian active enterprises (known as ASIA register) contains information on the economic units practicing arts and professions in industrial, business as well as services activities. It provides structural and identification information of the statistical units (active enterprises) such as economic activity sector, employed and self-employed number, legal condition, turnover and so on. It represents not only the informative background for the analysis on the structure and demography of Italian enterprises, but also the reference population for the ISTAT researches on Italian firms.

The final database[6] used for the empirical research development has been obtained by linking the two data sources described above. It contains 22 quantitative variables (some of them constructed by modifying the variables belonging to the original databases) measured on 81.706 Italian small and medium enterprises in 2008.

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[5] Missing data have been imputed by means of the Hot-Deck imputation approach; the issue of the indicator sensitivity to extreme values has been faced by adopting a winsorizing procedure for the lowest and highest 0.02% variables observations, replacing those extreme values with the values of trimming thresholds.

[6] The data have then be checked for normality, by means of the Shapiro-Wilk test and of the Q-Q plot graphical method. The results revealed that the variables under analysis were non-normal and that they were characterized by high skewness levels, due to the large amount of zero values characterizing most of the disposable variables. For this reason the decision has be made to transform them in order to eliminate skewness and to try to turn them to nearly symmetric normal-like distribution. To this end the Box-Cox transformation has been chosen, with the optimization for normality of λ parameter in each variable. The results showed that the transformation did not contribute to the "normalization" of variables, that continued to be characterized by high skewness. This is the reason why the original variable have been utilized for the rest of the study.

A first, explorative analysis has been run (by adopting an external weights estimation scheme taking into account the formative nature of the measurement model), for the assessment of the relationship linking competitiveness dimensions to their own indicators (Table 2); and a factorial scheme for the estimation of the causal relationships between the five dimensions and the overall competitiveness latent construct.

***Table 2** - Explorative Competitiveness Measurement Model Estimates*

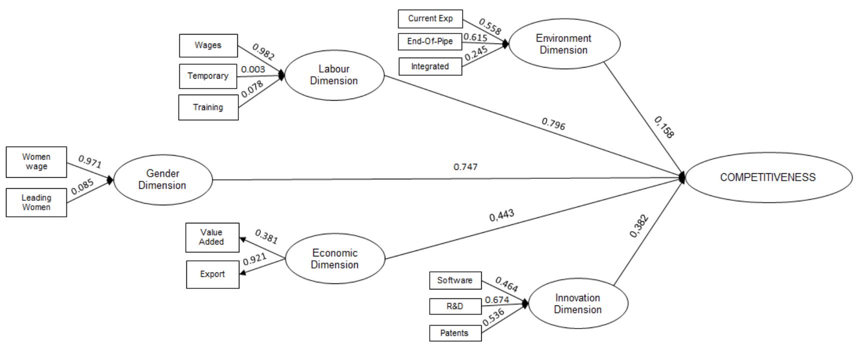
Latent Variables	Manifest Variables	Outer Weight	Outer weight Bootstrap	Standard Error
ENVIRONMENT	*Current expenditure*	0.36*	0.33	0.15
	End of pipe	0.80*	0.80	0.10
	Integrated investments	0.21*	0.21	0.06
INNOVATION	*Advertising*	0.10	0.09	0.06
	Software	0.46*	0.43	0.08
	R&D	0.29*	0.27	0.06
	Patents	0.31*	0.29	0.07
GENDER	*Women*	-0.59	-0.59	0.01
	Women wages	0.85*	0.85	0.01
	Leading women	0.23*	0.23	0.01
ECONOMIC	*EBITDA*	0.02	-0.01	0.04
	Value added	0.43*	0.47	0.05
	Openess	0.91*	0.89	0.04
	Depreciation Rate	-0.10	-0.08	0.13
	ROS	-0.04	-0.04	0.04
LABOUR	*Fixed Term*	0.00	0.00	0.00
	Part Time	0.00	0.00	0.00
	Average wages	0.99*	0.99	0.01
	Temporary work	0.12*	0.13	0.02
	Workers training	0.13*	0.13	0.02
	Project work	0.01	0.01	0.00

*p<0.05

The first PLS analysis made possible a process of selection of the observed variables: those indicators that resulted to be unable (in terms of weights and bootstrap-derived t-score) to form their own latent construct were removed, and a second, final analysis has be re-run. In the PLS estimates of the external weights, representing the contribute of the observed variable in determining the competitiveness dimension they are linked to, are presented.

The analysis of the t-scores obtained via non-parametric bootstrap techniques revealed the existence of some non-significant weights (highlighted in bold line). Thus the decision to delete from the model those variables unable to significantly determine the competitiveness dimension they have been hypothesized to be linked to has been made and the new model deprived of the non-significant variables has been run.

Figure 1 *- Competitiveness Model Parameters Estimates*



The choice of the final competitiveness model has been made on the basis of the results obtained by the explorative analysis and therefore realized by the removal of the non-significant variables. It is composed as follows: the number of competitiveness dimensions remained unchanged, there are only few differences in the composition of two of them[7].

[7] Three variables representing the contractual typologies trough which workers are employed were deleted from the labour dimension, and two profitability variables were eliminated from the economic dimension. The above mentioned results were not surprising as the variables revealing non significance relationships with the competitiveness dimensions they were linked to were "experimental" measures, never

The results of the PLS analysis on the final competitiveness model will be presented by using the following framework: the output of the measurement model estimation process will first be shown, followed by the output of the structural model estimates, finally goodness of fit measures will be presented, in order to evaluate the overall competitiveness model.

4.1 Measurement Model Estimates

The PLS estimates of the measurement model allowed us to understand to what extent observed variables contribute in determining the corresponding competitiveness dimensions; that is, we obtained the estimates of the weights characterizing the first order level of the competitiveness hierarchical model. First of all, it is possible to notice, by analyzing Table 3, that all the relationships linking manifest variables to the related competitiveness dimension are statistically significant. In particular, it would be interesting to analyze each latent competitiveness dimension for understanding which observed variable has the most relevant role in determining it.

The results of the weights estimation process showed that the labour dimension of competitiveness is mostly influenced by the variable representing the annual average wages per employee. The other variable respectively measuring the firm investments in workers training and the number of temporary workers have a significant, positive, but certainly lower impact. These results allowed us to understand that the labour dimension of competitiveness is determined not only by the firms organizational ability in improving their employees competences and skills or in answering to the external ever-changing environment, by using more flexible systems of workforce recruitment, but also, and above all, by the way in which firms treat their employees. In particular, the employees’ wages amount is the elements reveling the level of workers job satisfaction and, therefore, their occupational performance (they can also be considered as a proxy of the employee level of skills).

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used (apart from the EBITDA indicator) in previous empirical researches that we decided to put on our model in order to test their validity.

***Table 3** - Measurement Model Estimates*

Latent Variables	Manifest Variables	Outer Weight	Outer weight Bootstrap	Standard Error
LABOUR	*Wages*	0.98*	0.98	0.00
	Temporary work	0.09*	0.09	0.01
	Workers training	0.08*	0.08	0.02
GENDER	*Women wages*	0.97*	0.97	0.01
	Leading women	0.08*	0.09	0.01
INNOVATION	*Software*	0.67*	0.67	0.06
	R&D	0.46*	0.46	0.05
	Patents	0.54*	0.53	0.07
ENVIRONMENT	*Current expenditure*	0.56*	0.54	0.08
	End of pipe	0.61*	0.63	0.08
	Integrated investments	0.24*	0.24	0.07
ECONOMIC	*Value added*	0.38*	0.41	0.06
	Openess	0.92*	0.91	0.03

*p<0.05

The gender equality dimension is mostly determined by the gender pay gap variable, measuring the differences in the wages earned by men and women; it is also determined, even if to a smaller extent, by the number of women holding managerial positions. This result confirms that the gender equality policies of firm are mostly influenced by the implementation of actions aiming at the wages equality achievement, independently of the employees gender, as well as by giving to women the chance to compete for reaching leading positions inside firms.

The innovation dimension of competitiveness is determined, nearly to the same extent, by firms investments in software, patents and licenses as well as in research and development activities. These estimates confirm the relevance of such investments in determining the innovativeness level of firms.

As far as the environmental dimension is concerned, an element of novelty with respect to the previous empirical researches on micro-level environmental performance has to be underlined: the variable representing the end-of-pipe investments is the most relevant measure determining the level of firms environmental performance, the variable measuring integrated investments has instead the lowest impact.

On the contrary, previous studies proved that environmental proactivity (measured through the amount of integrated investments in fair environmental activities) is the most important determinant of a firm environmental performance, while end-of-pipe investments seem to have lower relevance.

The economic dimension of competitiveness is significantly determined by the two variables composing it. In particular the variable measuring firms export revenues on the overall turnover has a greater (positive) impact with respect to the variable measuring the firm value added per employee. This confirms the importance of the value added measure in determining the economic dimension of competitiveness and proves that ability of a firm to generate export earnings is a key indicator of its economic performance and its ability to create wealth.

4.2 Structural model estimates

The second order parameters of the micro-level competitiveness hierarchical model, representing the causal relationships between the hypothesized dimensions and the overall competitiveness latent construct, are the most important element to be analyzed in order to understand the main features of the model-based competitiveness indicator.

In Table 4 the PLS estimates of the structural weights (that are used in the aggregation phase of the composite competitiveness indicator) are reported. Each weight represents the contribution of the different pillars on the competitiveness indicator; that is, the regression coefficients in the structural model estimated on the standardized latent variables scores.

An important element to be underlined is the significance of each of the structural relations that confirm the theoretical hypotheses made on the structure of micro-level competitiveness: the hierarchical second order model is able to explain the complexity characterizing the multidimensional nature of competitiveness.

***Table 4** - Structural Weights Estimates*

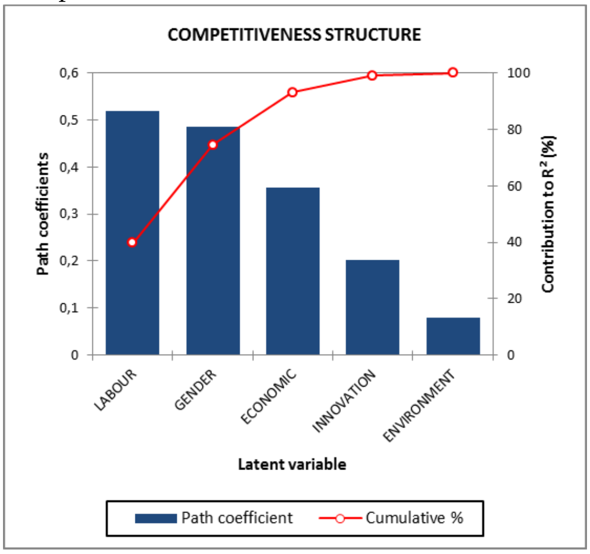
Latent variables	Path coefficient	Path coefficient (Bootstrap)	Standard error
LABOUR	0.52*	0.52	0.03
GENDER	0.48*	0.48	0.01
INNOVATION	0.20*	0.21	0.01
ENVIRONMENT	0.08*	0.08	0.01
ECONOMIC	0.36*	0.36	0.01

*p<0.05

Figure 2 shows the contribution of each pillar to the overall competitiveness indicator.

We found that the main drivers of competitiveness are the labour and gender dimensions, followed by the economic, the innovation, and the environment pillars.

***Figure 2** - Impact And Contribution Of Competitiveness Dimension On The Overall Competitiveness Indicator*



Better explaining, despite all the dimensions specified in the model significantly contribute in affecting firms competitiveness levels, some of them have a greater influence. In particular, the results of the structural parameters estimation process let us understand that firms investing both in human and organizational capital, by means of on-the-job employees training, fair wages polices as well as by the ability to adapt to the ever-changing external environment conditions through flexible form of workforce recruitment, and in gender equality policies, giving women the chance to advance their career and remunerating them to the same extent of men, are more likely to be competitive.

Another important function in determining competitiveness is carried out by the economic and innovation dimensions. It is possible to state that the economic wellness of firms is a core element for their development, it is the *sine qua non* condition for competitiveness as it enables firms to successfully implement a series of advanced policies, allowing them to gain greater competitive advantages. Innovation, realized through investment in research and development, licenses and patents, and informatics is another important aspect fostering competitiveness, even if to a lower extent with respect to the economic, labour and gender dimensions. This is probably due to the fact that the contribution to competitiveness given by innovation-driven policies and, therefore, by intangible measures linked to the development of innovative products and processes is collateral with respect to the main features concerning the human resources management; that is, despite the recognized importance of innovation in fostering competitiveness, the key element for increasing micro-level competitive advantages is an intensive and fair use of human resources that are the driving forces of firms successes.

As far as the environmental pillar is concerned, the results show that it has a significant, but weak relationship with competitiveness. It is not a crucial element, it only marginally helps in contributing to competitiveness, without playing a determinant role.

4.3 Competitiveness index computation and evaluation

From a composite indicator point of view, once the latent variables scores representing each competitiveness dimension level have been estimated, and the weights measuring their impact on the overall micro-level competitiveness measure have been obtained, it is possible to bring together all the disposable information by aggregating them in order to form the final competitiveness composite indicator.

Resuming, the analysis of the structural relationships linking micro-level competitiveness to its hypothesized determinants showed that improving firms competitiveness means to assign different levels of priority to firms policies implementation; in particular investments in human resource and a fair and dynamic management of human capital seems to be unavoidable elements for companies to be competitive[8]. Once the competitiveness model parameters have been estimated, the last step to be computed in order to close the composite indicator construction phase is the competitiveness model evaluation. It has been realized in a PLS framework. In the next section the obtained results will be presented and discussed. The micro-level competitiveness model has been validated at three levels: we analysed the quality of the measurement model, the quality of the structural model and of each structural regression equation. As far the measurement model is concerned, a first, preliminary study on the relationships between each manifest variable and the competitiveness dimension it has been linked to has already been conducted by means of the correlation analysis (Table 5) carried out for each competitiveness dimension.

It shows low correlations among the manifest variables forming each pillar, letting us conclude that each observed variable is a measure of a different feature charactering the competitiveness pillar it is linked to.

Moreover, during the parameter estimation phase we had the chance to test the significance of the relations linking the competitiveness pillars to their own observed variables by means of bootstrap procedures that

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[8] The results of the present study confirm the hypothesis, supported by a series of studies (Barney, 1995), that among the categories composing the concept of intellectual capital, the most relevant in determining firms competitiveness is the one concerning the human capital management.
The strong contribution of the labour and gender dimensions (strictly related to the concept of human capital) in determining firms competitiveness level confirms the results of previous empirical studies on intangible assets reveling that, among the several intangible resources of firms, those connected to the notion of human capital have greater impacts on competitiveness.

allowed us to individuate and to eliminate the non-significant variables, thus estimating again the competitiveness model.

Table 5 *- Competitiveness Dimensions Correlation Analysis*

Correlation matrix (Labour dimension)						
fixed	1					
part time	0.03*	1				
wages	0.01*	0.01	1			
temporary	-0.01	-0.01	0.06*	1		
work training	0.00	-0.01	0.05*	0.01	1	
project	0.00	0.01*	0.01*	0.00	0,00	1

Correlation matrix (Economic dimension)					
EBITDA	1				
value added	0.00	1			
openess	0.00	0.01*	1		
depreciation rate	0.02*	0.41*	0.00	1	
ROS	0.00	0.01	0.00	0.00	1

Correlation matrix (Innovation dimension)				
advertising	1			
software	0.02*	1		
R&D	0.03*	0.02*	1	
patents	0.08*	0.03*	0.02*	1

Correlation matrix (Environment dimension)			
current exp.	1		
end of pipe	0.26*	1	
integrated inv.	0.25*	0.02*	1

Correlation matrix (Gender dimension)			
women	1		
women wages	0.17*	1	
leading women	0.31*	0.31*	1

*p<0.05

Assessing the quality of the measurement model has a fundamental relevance for the identification of multicollinearity problems that may arise from the formative specification of the relationships between the competitiveness dimensions and the corresponding observed variables.

Specifically, the PLS tool for measuring the measurement model quality is the communality index, that can be computed both for each specified dimension and for the overall measurement model. Both the results are reported in Table 6.

Table 6 *- Mean Communalities Values For Each Competitiveness Latent Variable*

Latent dimensions	Latent dimension type	Mean communalities
LABOUR	Exogenous	0.34
GENDER	Exogenous	0.57
INNOVATION	Exogenous	0.35
ENVIRONMENT	Exogenous	0.45
ECONOMIC	Exogenous	0.50
COMPETITIVENESS	Endogenous	0.12
Mean		0.27

The communality index measures how much of the manifest variable variability in each block is explained by its own latent variable, that is, how well the manifest variables describe their underlying latent construct. This means that it is conceptually appropriate whenever measurement models are reflective. However, communalities can be also computed and interpreted in case of formative models knowing that, in such a case, the expected result are lower communalities values, revealing that each observed variable represents a different feature of the dimension it is linked to, and that multicollinearity is not a problem to be faced. Table 6 shows the communality index for each latent variable composing the competitiveness model. Communality indexes are very low for most of the dimensions, in particular it should be underlined that the competitiveness indicator dimension has the lower communality index value, that confirms that the dimensions selected in order to measure it effectively measure different, non-overlapping aspects of the phenomenon under analysis.

As far as the structural model is concerned it is possible to assess its quality by means of the redundancy index measuring the portion of variability of the manifest variables connected to the endogenous latent variable explained by the latent variables directly connected to the block. In our hypothesized model the redundancy index is 0.113, which means that the hypothesized model explaining the relationships among competitiveness dimensions and the overall competitiveness indicator are able to explain most of the variability of the phenomenon object of the present study.

Moreover, the PLS competitiveness model evaluation provided us with an overall goodness of fit measure: the GoF index. It has thus been possible to evaluate the overall specified competitiveness model, and to test the GoF index reliability by using bootstrap techniques.

Table 7 shows the obtained results. It displays two goodness of it measure: the absolute GoF index, calculated as the geometric mean of the average communality index and the average R^2, and the relative GoF index, obtained by dividing the absolute value by its maximum value achievable for the analyzed dataset.

Table 7 *- Micro-Level Competitiveness Model Goodness Of Fit Measures*

	GoF	*GoF* (Bootstap)	Standard Error
Absolute	0.52	0.52	0.02
Relative	0.98	0.96	0.03

The indexes displayed in Table 7 confirm that the second order hierarchical model specified in order to study micro-level competitiveness is able to explain the features of the phenomenon under analysis in a suitable way.

5 Concluding Remarks

In this paper, a new view of competitiveness based on its multidimensional nature has been assumed with the objectives: (i) of analyzing the relationships among the main elements defining competitiveness, and understanding which of them influence competitiveness in a more powerful way; (ii) and of building a micro-oriented composite indicator by means of Structural Equation Model-based approach.

We specified a competitiveness model grounded on the hypothesis that each competitiveness dimension is directly linked to the overall competitiveness indicator, thus originating a hierarchical second order model (the first order level being composed of the five competitiveness dimension and the second one by the overall competitiveness latent variable). The specified model has been used for the empirical analysis conducted on the small and medium Italian enterprises sample in 2008.

The Structural Equation Models non-parametric estimation process showed that the main drivers of competitiveness are the labour and the gender dimensions, followed by the economic, the innovation, and the environment pillars. Better explaining, despite all the dimensions specified in the model significantly contribute in affecting firms competitiveness levels, some of them have a greater influence. More specifically, our results seem to suggest that firms investing both in human and organizational capital - by means of on-the-job employees training, fair wages polices as well as by the ability to adapt to the ever-changing external environment conditions through flexible form of workforce recruitment, and in gender equality policies, giving women the chance to advance their career and remunerating them to the same extent of men - have more chances for competitive advantages. Improving firms competitiveness means to assign different levels of priority to firms policies implementation; in particular investments in human resources, and a fair and dynamic management of human capital seems to be the unavoidable element for companies to be competitive.

Our results also confirmed that the hypothesized hierarchical second order model is able to explain the complexity characterizing the multidimensional nature of competitiveness, moreover it has been possible to prove the hypothesis, already supported by a series of empirical studies, that among the categories composing the concept of intellectual capital, the most relevant in determining firms competitiveness is the one concerning the human capital management.

Finally, the estimation phase allowed us to obtain both the competitiveness dimensions and the model-based competitiveness composite indicator scores for the Italian sample. We used them for trying to trace the profile of the most competitive Italian firms.

The competitive Italian firm-type emerging from our study is located on the north-east of Italy, develops its activities in the high-tech manufacturing sector by employing a number of workers greater than 50; is a firm with a wealthy economic situation, investing on human capital, careful to gender policies and able to adapt its productive processes to ever changing environmental external conditions.

The research on micro-level competitiveness furnished interesting results both on the phenomenal and on the methodological point of view, several open scenario would however be taken into account.

Starting from the hypotheses that competitiveness is the result of a number of factors interacting among each other as well as with the surrounding environment, and that elements characterizing competitiveness such as trade, labour mobility, technology and knowledge diffusion are a sources of geographical dependence among firms, the investigation of the role and weight of potential spillover and spinoff effects among firms should represent a future development of our proposal. In this respect, one possibility is to assume that competitiveness levels of firms influence and are in their turn influenced by the performance of the surrounding firms, giving rise to spillover effects. Interesting developments would therefore arise from a spatial analysis, carried out in a non-parametric Structural Equation Models framework, for exploring the potential spatial structures, with the final aim of detecting clusters of high or low performers among firms.

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