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Development and Validation of a Measure for Product Innovation Performance: The PIP Scale

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Abstract
Innovation performance evaluation is a crucial issue in innovation management research. Based on existing literature, qualitative and quantitative surveys, a measurement scale for product innovation performance (PIP) was developed and assessed. We defined PIP through five dimensions: financial performance, market performance, customer performance, technical performance and strategic performance. The validity of this scale was tested via structural equations modeling (SEM) based on a dataset from the French biotechnology industry. Results supported our conceptual model and showed that all dimensions measurements were validated. In addition, these dimensions were complementary, strongly correlated and, had strong positive link with PIP. These findings underlie the importance to consider these five PIP dimensions simultaneously in order to improve and/or to evaluate new product results.

Keywords: *Product Innovation Performance, Measurement Scale, Structural Equation Modelling*
JEL Classification: M11; O32; L25; C39

1. Introduction

The new global context is dominated by a rapid pace of technological changes, shrinking product life cycles, increasing customer demands, more productivity and quality requirements and fierce global competition (Evanschitzky et al, 2012). In this context, particularly for Knowledge-intensive firms, technological innovation is regarded as a key element of maintaining and improving competitive advantages (Garcia-Muina et al, 2009). To achieve product innovation performance, firms need a deep understanding of innovation dynamics, well thought innovation strategy, well-defined process of innovation strategy implementation, and above all profound tools to measure innovation performance.

Evaluation of Product Innovation Performance (PIP) is a critical issue on innovation management research (Tatikonda 2007; Blindenbach et al, 2010). PIP measurement is gaining importance as its effectiveness and efficiency not only determines an organization's competitive advantage, but also its very survival (Cedergen et al, 2010). Tatikonda (2007) reported that innovation performance measurement is an expansive and elusive subject. This author explained

that “This is due to the multiplicity of meanings associated with performance measurement; the varied, but simultaneous, roles that performance measurement plays; and the numerous, distinct customers of performance measurement” (Tatikonda, 2007, p.1). Given the importance of product innovation performance, its measurement is a daunting challenge. In fact, both researchers and managers require a relevant measurement instrument of PIP (Alegre et al, 2006). In that spirit, the aim of this paper was to develop and assess a measurement scale for PIP. We tested the validity of this instrument based on a sample of 100 French biotechnology firms (BF).

The paper unfolds as follows: First, the state of the art is presented. It aims to highlight the importance of developing a measurement scale of the PIP. Next, our expanded understanding of the PIP is described. Then, the research methodology is outlined. Finally, results are presented and main conclusions are discussed.

2. Literature review

2.1.State of the art of Product innovation performance measurement

The PIP is a broad concept, which definitions are various and therefore its measurements are quite heterogeneous. This performance can be presented from many points of view: commercial, financial, technical, global, etc. Given that the primary goal of a product innovation is to generate a profit, the most used criteria by firms to assess performance are based on financial and market aspects (Suomala, 2004). However, using only these criteria is considered so restrictive and narrow since the product benefits range is wider and richer. It was shown that product innovation could have as objectives/ effects: improvement loyalty of existing customers, improvement of the company image, grow into new markets, etc. (Storey and Easingwood, 2009). These authors argued that these effects are of considerable importance to a firm. However, these benefits - termed “company benefits” by Storey and Easingwood, (2009) - are less frequently used by firms to measure their PIP.

Some empirical research found that some criteria such as customer satisfaction, reputation and competitive advantage produced, despite being considered by managers to be the most useful, are rarely mobilized as measures in reality (Driva et al, 2000).

In a survey of PIP measurements in the U.S. and Europe, the following measurements were identified as being those most commonly used : total cost of the project, on-time delivery of development project, actual project cost compared to budget , actual versus target time for project completion and lead time to market (Driva et al, 2000). These authors compared measures recommended by academics to those used by practitioners. They concluded that measures appearing in common (practitioners and academics) include target time for project completion, total cost of the project, time to market, etc. However, while practitioners placed more emphasis on costs and time, academics attach more importance to customer orientation. This highlights the importance of developing performance measures affecting financial, market, technical and customer sides.

To indicate which firms were in better control of their PIP, AberdeenGroup (2005) mobilized metrics around percent of products meeting targets with regard to: revenue, product cost, launch date, product quality and development cost.

When quantifying practices’ impact of best-performing businesses on PIP, Cooper and Edget (2012) used these metrics: revenue and profits from new products, proportion of projects hitting their targets, productivity, performance against sales and profit goals.

Boston Consulting Group indicated that measures considered most valuable by executives were time to market, new product sales, and return on investment in innovation (Adams et al, 2008).

The common feature of the above measures is that they are one-dimensional order. We present in what follows multidimensional ones.

Blindenbach et al, (2010) defined PIP as the combination of two dimensions: operational performance and product performance. "Operational performance reflects how the innovation project was executed, while product performance evaluates the commercial outcome of an innovation project" (Blindenbach et al, 2010, p. 574). The first dimension includes adherence to schedule and budget targets and quality. The second dimension comprises financial and market aspects such as adherence to profit targets, growth targets, market share targets, competitive advantage, and customer satisfaction.

Based on a survey among product development managers, Griffin and Page (1996) categorized PIP measurements in three dimensions: (1) customer-based success; (2) financial success; and (3) technical performance success.

Cooper and Kleinschmidt (1995) found that PIP measures they listed produced three dimensions. The first is financial performance, including profitability, payback period, sales, profits. The second is market impact and is measured by domestic market share, foreign market share. The last dimension is termed 'opportunity window' and regroups window on new categories of products, window on new markets.

A study conducted by Storey and Easingwood (2009) on consumer financial services sector in UK about the types of new product performance has identified three distinct dimensions of performance: sale performance, profitability and, enhanced opportunities. Sales performance consists of revenue, market share, growth in sales against the goal. Profitability is measured by the level of profits and profits against targets. Enhanced opportunities "very much show the long-term benefits that can occur from introducing a new product. Repositioning the company, opening up a new market, and a platform to introduce further new products, indicate an improved likelihood of long-term company prosperity" (Storey and Easingwood, 1999, p.195).

Alegre et al, (2006) conceived PIP as a combination of two dimensions: efficacy and efficiency. Efficacy evaluates the success of an innovation, while efficiency assesses the effort carried out to achieve that success. Product innovation efficacy was inspired mainly by the instrument proposed by the OECD's Oslo Manual (2005). Product innovation efficiency was based on a comparison with firms' competitors on these metrics: average innovation project development time, average cost per innovation project, global satisfaction degree with innovation project efficiency.

Hsu and Fang (2009) identified four PIP dimensions: Market performance (revenue, market share, market forecast accuracy, etc.); Financial performance (overall profitability, investment return); Customer performance (customer satisfaction, customer acceptance); and Product performance (quality, competitive advantages, and launch on time).

In what follows, we analyze these works in order to present an expanded understanding of the PIP concept.

2.2.Broad understanding of the PIP

In this section, we present our expanded understanding of the PIP concept. Its aim is to prepare the basis for empirical research to build a PIP measurement scale.

Because no single measurement can evaluate PIP, many authors - as presented above - insisted on a multidimensional approach. For this reason, we choose to do our analysis based on multidimensional approaches. In table 1, we compare four PIP scales in order to determine terminologies to adopt and items to mobilize in our empirical study. Given that PIP scales developed by Storey and Easingwwod (2009) and Cooper and Kleinschmidt (1997) are relatively similar, we include them in the same terminology. We collected forty-two items from previous studies, and removed similar or same items, reducing the total to twenty-eight items as presented in table 1.

Table 1: Expanded understanding of PIP measurement scales

Authors	Griffin and Page (1996)			Hsu and Fang (2009)				Blindenbach et al (2010)		Alegre et al (2006)		Storey and Easingwood (2009)		
Items /Dimensions	Fp	Tp	Cp	Fp	Cp	Mp	Pp	Op	Pp	Ece	Eca	Sp	Pr	Eo
Market share against objectives	x					x			x		x	x		
Profitability against objectives	x			x					x				x	
Opening of new markets abroad											x			x
Improved customer loyalty			x		x								x	
Customer satisfaction			x		x				x			x		
Sales/Revenue against objectives	x					x			x			x		
Improved company reputation									x					x
Enhanced competitive advantage		x					x		x					x
On time delivery/Launch		x					x	x		x				
Adherence to budget		x						x		x				
Better quality compared to your other products		x					x	x						
Better profitability compared to your other products	x			x					x				x	
Better market share compared to your other products	x					x			x		x	x		
Better sales/revenue compared to your other products	x					x			x			x		
Development of environment-friendly products											x			
Enhanced domestic market share											x	x		
Enhanced foreign market share											x	x		
Repositonning the company														x
Platform to introduce further new products														x
Enhanced profitability of other product									x					x
Overall satisfaction with targeted objectives									x					x
Replacement of products being phased out											x			
Improve health aspects														
Improve safety aspects														
Meet regulatory requirements														
Extension of product range within main product field											x			
Extension of product range outside main product field											x			
Opening of new domestic target groups											x			x

Fp: financial performance, Tp: technical performance; Cp: customer performance; Mp: market performance; Pp: product performance, Op: operational performance; Ece: efficiency; Eca: efficacy; Sp: sales performance; Pr: profitability; Eo: enhanced opportunities

When comparing these scales, we remark that except, Alegre et al work, the most used criteria are based on financial and market aspects. In general, what is classified by Griffin and Page (1996) as technical performance, is classified by Hsu and Fang (2009), Blindenbach et al (2010) and Alegre et al (2006) as product performance, operational performance and efficiency product, respectively. Similarly, financial and market aspects - grouped by Griffin and Page (1996) in one dimension: financial performance - are integrated in product performance dimension by Blindenbach et al (2010) and in sales and profitability dimensions by Storey and Easingwood (2009). Alegre et al (2006) omit the financial aspects. While customer aspects are treated as a separate dimension of performance by Griffin and Page (1996) and Hsu and Fang (2009), the other authors include them in more general dimensions. The least common dimension between these instruments is "enhanced opportunities". In this context, we note nonetheless that "enhanced competitive advantage" is the most used item by the authors. Oddly, Griffin and Page (1996) and Hsu and Fang (2009) include competitive advantage in their technical and product performance dimensions respectively. However, competitive advantage is not necessarily related to the technical process, but is more likely the result of product features as suggested by Blindenbach et al (2010). Other items such as "Improved company reputation » and « Overall satisfaction with targeted objectives" are also adopted by Blindenbach et al (2010) in their product performance dimension.

At the end of the description of these measurement scales, we see that apart from conceptual differences within each PIP model, differences exist also about which items to adopt and how to group them. Nevertheless, if these models vary with respect to each research tradition, they have a number of common characteristics. This is manifested by some recurring key themes such as financial, market and technical performances.

The scales presented above formed the basis of a qualitative test which aim was to choose the appropriate terminology to adopt and to precise dimensions and their corresponding items to include in our PIP scale.

3. Methodology

In this work, we mobilize a two-stage research design, including preliminary qualitative and quantitative surveys. The purpose of the qualitative study is to obtain compatible measures of product innovation performance in the biotechnology industry. The quantitative survey tests the validity of the proposed PIP scale.

3.1.Preliminary study

To construct the PIP measurement scale, we followed a methodological approach inspired by the paradigm of Churchill (1979). The first step was the establishment of the construct domain. This step was based in part on our review of the literature and is crowned by our broad conception of the PIP. Then, to finish this first step, we submitted this broad conception to a qualitative study. The mobilization of a qualitative method in a positivist research upstream or downstream of a quantitative method is a common and useful practice in social sciences (Gavard-Perret et al, 2008). These latter suggest that to build a measurement scale, the researcher previously needs to go through a qualitative collection phase to be able to understand what the concept covers exactly and to collect the truly used language by professionals about this concept.

In addition, this method has been used by many authors in the innovation management research (Hsu and Fang, 2009).

We conducted the preliminary study was through a questionnaire sent via mail to 11 R&D managers of biotechnological firms. We have received seven usable responses. First, we asked the respondents to adjudicate on the selection of a homogeneous terminology themes to measure PIP. Second, we asked them to comment on these themes to see if they cover the essential assessing the PIP. Then we asked them to judge the items in each theme (dimension); the objective was to ensure the content validity of the scale. Respondents opted unanimously for the terminology adopted by Griffin and Page (1999). They indicated that terminology adopted by Blindenbach et al (2010) is not adequate since it is somewhat ambiguous and even stranger to the dominant culture in the field. The terminology adopted by Alegre et al (2006) has been discarded since - as explained by respondents - it does not take into account important points such as financial performance, quality improvement and customer satisfaction. Given that the Griffin and Page terminology combines financial performance and market performance in one dimension, respondents criticize it. They believe that firms could be brought to make trade-offs between these two dimensions; hence, the importance of measuring these dimensions separately as suggested by the respondents. The dimension "enhanced opportunities" proposed by Storey and Easingwood (1999) found a good echo among respondents. In fact, these latter suggested that it is interesting to integrate this dimension in the terminology to be adopted. However, they indicated that they preferred to replace the expression "enhanced opportunities" by "strategic performance". They explained that "enhanced opportunities" is an ambiguous term, not usually used in PIP measurement logic. For this purpose, the "strategic" attribute is clearer and more illustrative and insofar as this topic describes the benefits of innovations rather in a long-term orientation. Respondents indicated their disagreement to place the item "competitive advantage" to the "technical performance". They rather suggest adding this item to "strategic performance." Moreover, we have raised this remark in the previous section. For this reason, we considered this remark by making the necessary adjustments. In addition, this proposal is in line with the «enhanced opportunities» concept proposed by Storey and Easingwood (2009).

In light of the foregoing and in agreement with the literature, we generated eighteen items for PIP measurement and classified them into five dimensions: financial performance, market performance, technical performance, customer performance and strategic performance (Table 2).

Table 2: The proposed dimensions of the PIP scale

Dimension	Statut	Item	Statut
Financial	Initial	Profits attributable to new products are higher than those provided by the remaining products	Initial
		New products have achieved the objectives set in terms of profit	Initial
		New products have achieved the objectives set in terms of return on investment	Added
Market	Added	New product sales are greater than those provided by the rest of the products	Initial
		New products have achieved the objectives set in terms of sales	Initial
		Compared with other products of your company, new products have achieved superior results in terms of market share	Initial
		New products have achieved the objectives in terms of market share	Initial
		New products have allowed the penetration of new markets	Initial
Technical	Modified	The quality of new products is better than the rest of the products	Initial
		New products are launched in the deadlines	Initial
		New products are launched within budget Development Goals	Initial
		New products have reduced environmental damage, improved health and safety	Aggregated 3 in 1
Customer	Initial	Customers are satisfied with the performance of new products	Initial

		Compared with other products of your company, customer complaints regarding new products are fewer	Added
		New products have improved customer loyalty	Initial
Strategic	Added	New products provide the company a competitive advantage	Initial
		New products have reached all the goals set	Initial
		New products have improved the reputation of the company	Initial

These are the dimensions that will be tested in the quantitative research.

3.2.Sample and data collection

This study concentrates on product innovations in the French biotechnology industry. Analyzing a single industry is suitable in the evaluation of PIP since unit analysis (new products) will be homogeneous. Thereby, disturbances from other variables could be eliminated and product effects could be more comparable among sample firms. Selection of the biotechnology industry as our ground research was motivated by some factors. First, biotechnology firms (BF) are innovative in nature and their survival is dependent on their innovation performance. Second, BF qualified as "technology-based" and "science-driven" belong to high-tech sector with high potential of growth (De Luca et al, 2010) thus exhibiting knowledge-intensive and high value added features. Many researchers have used the biotechnology industry in the management innovation field (Alegre et al, 2006). Third, French biotechnology accounts nearly 10% of worldwide turnover (Ricard, 2010) and, ranks third across Europe behind the UK and Germany. In addition, this industry is promising in terms of human and animal health, environmental security, agricultural production, etc. This makes the biotechnology industry a strategic field of the national economy and thus valuable challenging domain of research.

French Biotechnology firms are listed in the national database of biotechnology (http://www.biotechnologiefrance.org/). To improve the reporting accuracy on the resulting performance data, increasing the homogeneity of our sample was taken into account. Indeed, we were only interested in private firms based in France and having produced at least one product innovation. In addition, are included in this study only firms with at least three years of existence as recommended by the OECD (2005). In fact, since innovation is a time dependent process, it is recommended to consider three-year periods to evaluate innovative, scientific and technological activities. Our final target population included 798 BF. We sent the questionnaire primarily to R&D managers because they are typically responsible of innovation programs and thus are well placed to respond to our questionnaire. We carried out fieldwork from February to April 2012. We sent the questionnaire by email with a letter explaining the purpose of our research project, emphasizing the confidentiality of the responses and proposing a feedback report on the survey results. Three weeks later, we sent a reminder email to non-respondents and a second questionnaire. These efforts produced 100 valid responses. Characteristics of our sample in terms of size (77% below 50 employees), age (51% below 10 years) and activity type (mainly in medical biotechnology) are congruent with those of biotechnology firms in France (Francebiotech, 2012). This bestows representativeness to our sample.

3.3.Measures

As indicated above (Table 2), we operationalize PIP as a variable with five dimensions: financial performance (FP: 5 items), market performance (MP: 3 items), customer performance (CP: 3items), technical performance (TP: 4 items) and strategic performance (SP: 3 items). We ask respondents to state the performance of their product innovation with regard to these dimensions using a Likert type scale ranging from 1= “not achieved result” to 5= “perfectly

achieved result". We conceptualized PIP as a second-order variable and these latter dimensions constitute the first order constructs (figure 1).

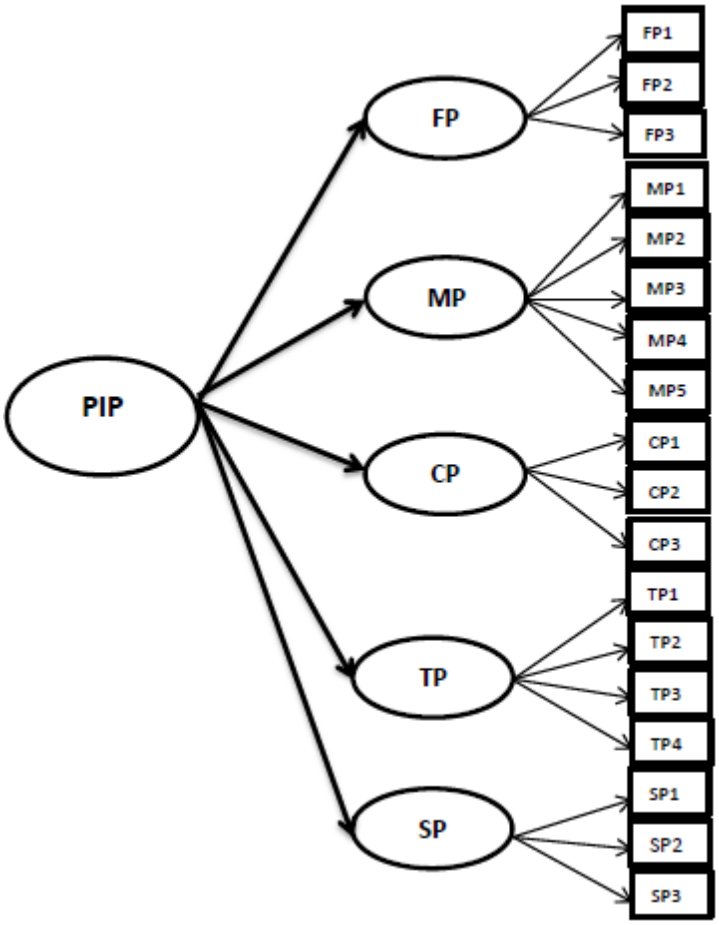

Figure 1: Conceptual framework

3.4.Analyses

The data analyses are set based on structural equation modelling (SEM) method. SEM allows researchers to integrate unobservable variables (latent variables) measured indirectly by indicator variables. The estimation technique we used under SEM is the Partial Least Square (PLS) using SmartPLS package version 2.0.M3. Compared to the Linear Structural Relations (LISREL) technique, PLS-SEM is a construct validation method (Jyothibabu et al, 2010), which is not rigid in multivariate normality and is more flexible in sample size to estimate path coefficients. This is especially relevant for this study, as our final sample size was 100 observations. In addition, PLS-SEM is efficient in modelling hierarchical latent variables (second order constructs) since it can deal with complex models and since it produces consistent parameter estimates (Hair et al, 2013).

4. Results

Given that we conceived PIP scale as a two-second order constructs, assessing its validity requires two steps: evaluation of the first-order model and evaluation of the second-order model. Then, we reserved a third paragraph to the structural model results.

4.1.First order constructs

The first-order constructs are financial product performance, market product performance, customer product performance, technical product performance and strategic product performance. In order to assess the validity and the reliability of each of these constructs, we initially carried out exploratory factor analysis (EFA), confirming their dimensionality. The convergent validity is assessed via item loadings. As shown in table 3, only one item was dropped being under the threshold of 0.7 as suggested by Hair et al (2013). This item is MP5 and refers to the ability of the new products to penetrate new markets. The rest of item loadings, ranging from 0.746 to 0.920, were significant ($t > 1.96$). The second criterion used to evaluate the convergent validity is the average variance extracted (AVE). AVE values of the five constructs range from 0.645 to 0.776. These values exceeded the acceptable cut off point of 0.5 (Hair et al, 2013) indicating convergent validity. The composite reliability (CR) and Cronbach's alpha (α) were above the required threshold of 0.7 confirming the good reliability of the constructs (table 3).

Table 3: First order constructs results

Dimension	Item	Mean	SD	Loading	α	CR	AVE	1	2	3	4	5
FP	**FP1**	3,25	1,104	,808*	,855	,912	,776	**,881**				
	FP2	3,30	1,005	,911*								
	FP3	3,22	,949	,920*								
MP	**MP1**	3,06	1,196	,770*	,838	,892	,675	,785	**,821**			
	MP2	3,18	1,019	,890*								
	MP3	3,21	1,018	,839*								
	MP4	3,12	1,018	,780*								
	MP5**	3,63	1,041	-								
CP	**CP1**	3,85	,978	,883*	,821	,893	,737	,606	,728	**,858**		
	CP2	3,69	,986	,871*								
	CP3	3,28	1,045	,819*								
TP	**TP1**	3,25	1,104	,772*	,815	,878	,645	,561	,704	,734	**,803**	
	TP2	3,06	1,153	,878*								
	TP3	3,14	1,239	,810*								
	TP4	3,46	1,137	,746*								
SP	**SP1**	3,98	1,044	,852*	,811	,888	,727	,692	,772	,778	,710	**,852**
	SP2	3,18	1,175	,809*								
	SP3	3,91	1,006	,894*								

**Significant at 0.001 (2-tailed) ; ** Dropped item*

To inspect discriminant validity, we calculate the square root of each construct's AVE (boldface diagonal elements in table 3) which should be larger than the level of correlations involving the construct (Chin, 2008). Table 3 shows that all constructs satisfied this requirement.

Therefore, we conclude that, at this stage, our model has the adequate validity to continue with an analysis of the second order construct.

4.2.Second order construct

To measure the dimensionality of the second order construct (PIP), we submitted first order construct scores to EFA. Results showed that the dimensionality is respected since the first factor had an Eigenvalue greater than one and the rest of the factors were lower than 1. The AVE value exceeded the acceptable cut off point of 0.5 indicating convergent validity (Table 4). CR and Cronbach's alpha are above the required threshold of 0.7 indicating that the PIP has an acceptable reliability. Furthermore, all PIP dimensions, as shown by table 4, are strongly related to the latent concept (PIP). The path coefficient of these five dimensions, ranging from 0.830 to 0.913, are acceptable as they are above the cut-off point of 0.3 (Chin, 2008) and significant ($t > 1.96$, $p < 0.001$).

Table 4: Second order and structural model results

Dimension	Path coefficient	t	R^2	Q^2	AVE_{PIP}	CR_{PIP}	α_{PIP}	Gof
PIF	,830*	19,514	69%	53.3%				
PIC	,913*	48,170	83.4%	56.6%				
PICL	,880*	26,513	77.5%	55.4%	**,767**	**,942**	**,946**	**76,6%**
PIT	,845*	23,507	71.5%	45.8%				
PIS	,905*	40,738	82%	57.7%				

**Significant at 0.001 (2-tailed)*

4.3.Structural model results

The regularly used criterion to evaluate the structural model is the coefficient of determination R^2. It measures the model's predictive accuracy (Hair et al, 2013). Dimension R^2 coefficients were high overall (Table 4) and range from 69% to 83%. Exceeding the cutoff level of 19%, R^2 values were quite good (Chin, 2008) and indicated a large predictive accuracy of our model. In addition to assessing the R^2 values, we also studied the Stone-Geisser Q^2 value. It is an indicator of the model's predictive relevance. The Q^2 test measures how well observed values are reproduced by the model when observations are removed from the analysis (Hair et al, 2013). Since all Q^2 values were greater than zero and ranging from 45% to55%, we can say that our model had a satisfactory predictive relevance (Wilson, 2010). Consequently, these great Q^2 values further strengthen the predictive ability of our model. Finally, the goodness of fit index (GOF) of the model was large 0.766 (Latan and Ghozali, 2012) meaning that the model was able to take into account 76.6% of the achievable fit. These results lend sufficient confidence that our model fits the data well. In sum, the PIP scale is validated and constitutes an appropriate measurement instrument in the French biotechnology industry.

5. Discussion and conclusions

The marks obtained by French BF for each of the PIP dimensions are all above the average point. This implies that product innovations produced by these firms are well in an acceptable threshold with a small superiority for strategic and customer performances (Table 3). Market performance was the most correlated dimension with the PIP scale. This indicates that the biotechnology industry is expanding and thus reflecting the increased weight taken by this industry in the national economy. Comes in the last range financial performance with a loading of 0.831. This is a logical result since; in general, new products in this industry, in addition to their substantial production and marketing costs, are distinguished by rather heavy development costs. This could have negative financial impacts with difficulties to recover invested funds.

Based on an effort integrating: (1) theoretical contributions on the product innovation management literature, (2) a conceptualization to take into account the criticisms of previous work, (3) a qualitative study and, (4) a quantitative study, we have developed and empirically validated a measurement scale of PIP in the French biotechnology industry. A rich and coherent set of five dimensions allowed merging and synthesizing disparate and fragmented contributions of the literature on PIP while specifying the neglected aspects. Exploratory factor analyzes showed that the scale has a very satisfactory reliability. Confirmatory analyzes, conducted using the structural equation modelling, and proved goodness of fit to the data collected, the convergent and discriminant validity of the scale dimensions.

Thus, we affirm that PIP is a concept that can be measured by five first order constructs and a second order construct. In other words, PIP is a second-order construct that strongly determines its five dimensions. Validation of the PIP scale as a multidimensional concept is in line with the work of Alegre et al. (2006). These authors showed that PIP is as a second order construct consisting of two dimensions: efficacy and efficiency. It should be noted that Alegre et al. (2006) work has been validated in the biotechnology industry in France. This gives more legitimacy to our study. In fact, we believe that besides the validation of similar approaches in the same context with similar results, our PIP scale is more comprehensive and deeper. In addition, our scale looks like that proposed by Hsu and Fang (2009). These authors mobilized the three dimensions (financial performance, technical performance and customer performance) proposed by Griffin and Page (1996) and added a fourth dimension: the market performance. Here, what distinguishes our scale from these ones is the addition of a fifth dimension "strategic performance". Thus, our results are consistent with previous innovation management literature: they show that financial performance, market performance, technical performance, customer performance and strategic performance can be considered as complementary dimensions of product innovation performance.

If it is necessary to check the stability of the PIP scale structure on other samples (other industries and /or other countries), the proposed scale shows, at this stage of development, satisfactory psychometric qualities. Here, our contribution is important to the literature on innovation management. This scale could be used for further research on innovation performance. Each of the five dimensions of the PIP scale could be mobilized as a variable in a given model, related to the company performance for example. This work also provides managerial contributions. The aim of the scientific validation of a model or a measurement instrument is its future use in practice with a confidence that this instrument is based on a well-established theory. Managers could use this scale in setting performance targets towards innovation products. This scale could be also adopted as a post evaluation instrument to assess PIP. It could be a sort of scorecard allowing to ask key questions about various levels of performance (financial, customer, etc.). In doing so, the assessment will pinpoint the necessary changes by determining strengths and weaknesses of a given product innovation. In addition,

given the complementary and the inter-correlation of our scale dimensions and their strong positive link with PIP, managers should, therefore, consider these five dimensions simultaneously to improve the PIP.

Our results have to be viewed in the light of the research's limitations. Generalization of the results is relative since this study took place in a single industry. Then, the perceptual measures used in this study with a single respondent could cause the "percept-percept bias". Another limit is induced by the goodness of fit of the model with the SEM-PLS since the index (GOF) adopted is still controversial (Hair et al, 2013).

These limits open perspectives for future research. First, in order to generalize the results, we can test the model based on objective measurements, on larger samples and in other contexts. Second, since the effective management of a performance measurement system is a distinctive organizational competence (Tatikonda, 2007), "future research should address the development and value of a dedicated performance measurement programs office or system" (Tatikonda, 2007, p. 19).

References

Aberdeen Group. (2005). New Product Development: Profiting from Innovation. Business Value Research Series. www.aberdeengroup.com

Alegre, J. Lapiedra, R. & Chiva, R. (2006). A measurement scale for product innovation performance. *European Journal of Innovation Management*, 9(4), 333-346.

Blindenbach, F. Dalen, J. Ende, J. (2010). Subjective performance assessment of innovation projects. *Journal of product innovation management*, 27, 572–592.

Cedergren, S. Wall, A. & Norström, C. (2010). Evaluation of performance in a product development context. *Business Horizons*, 53(4), 359-369.

Chin, W. (2008). Structural equation modeling in marketing: some practical reminders. *Journal of marketing theory and practice*, 16(4), 287-298.

Churchill, G.A. (1979). A paradigm for developing better measures of marketing constructs, *Journal of Marketing Research*, 16, 64-73.

Cooper, R.G. & Kleinschmidt, E. J. (1995). Performance typologies of new product projects. *Industrial Marketing Management*, 24(5), 439-456.

Cooper, R.G, & Edget, S.J. (2012). Best Practices in the Idea-to-Launch Process and Its Governance. *Research Technology Management*, 55 (2), 43-54.

De Luca, L. M. Verona, G. & Vicari, S. (2010). Market Orientation and R&D Effectiveness in High-Technology Firms: An Empirical Investigation in the Biotechnology Industry. *Journal of Product Innovation Management*, 27, 299-320.

Driva, H. Pawar, K. S., & Menon, U. (2000). Measuring product development performance in manufacturing organisations. *International Journal of Production Economics*, 63(2), 147-159.

Evanschitzky, H. Eisend, M. Calantone, R.J; & Jiang, Y. (2012). Success Factors of Product Innovation: An Updated Meta-Analysis. *Journal of Product Innovation Management*, 29, 21-37.

France biotech, (2012). *Panorama of the life sciences industry*, France Biotech, 10th edition. http://www.france-biotech.org

García-Muiña, F. E. Pelechano-Barahona, E. & Navas-López, J. E. (2009). Making the development of technological innovations more efficient: An exploratory analysis in the

biotechnology sector. *The Journal of High Technology Management Research*, 20(2), 131-144.

Gavard-Perret, M.L. (2008). Choisir parmi les techniques spécifiques d'analyse qualitative, In : *Méthodologie de la recherche*, Pearson Education France, 2008.

Griffin, A. (1997). PDMA research on new product development practices: Updating trends and benchmarking best practices. *Journal of Product Innovation Management*, 14(6), 429-458.

Hair, J. Hult, T; Ringle, C. Sarstedt, M. (2013). *A primer on partial least squares structural equation modelling (PLS-SEM)*. Los Angeles: Sage publications.

Hsu, Y. Fang, W. (2009). Intellectual capital and new product development performance: The mediating role of organizational learning capability. *Technological Forecasting and Social Change*, 76(5), 664-677.

Jyothibabu, C. Farooq, A. & Pradham, B. (2010). An Integrated Scale for Measuring an Organizational Learning System. *The Learning Organization*, 17(4), 303-327.

Latan, H. & Ghozali, I. (2012). *Partial Least Squares: Concept, Technique and Application using Program SmartPLS for Empirical Research*, Badan Penerbit Universitas Diponegoro, Semarang. .

OECD/Eurostat. (2005). *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*. 3rd Edition, The Measurement of Scientific and Technological Activities, OECD Publishing.

Ricard, S. (2010). *Biotechnology in Auvergne*. Regional Department of Enterprise, Consumer, Labour and Employment Auvergne, France. Auvergne: Bongo. http://www.auvergne.direccte.gouv.fr.

Schilling, M. (2005). *Strategic Management of Technological Innovation*. New York. Mac Graw Hill International Edition.

Storey, C. Easingwood, C. (1999). Types of new product performance: evidence from the consumer financial services sector. *Journal of Business Research*, 46, 193-203.

Suomala, P. (2004). Multifaceted new product development performance: survey on utilization of performance measures in Finnish industry. *Performance measurement and management control: superior organizational performance: studies in Managerial and financial accounting*, 14, 203-233.

Tatikonda, M.V. (2007). Product development performance measurement. In: Loch, C., Kavadias, S. (Eds.), *The Handbook of New Product Development*. Elsevier Publishers, Oxford, United Kingdom

Wilson, B. (2010). Using PLS to Investigate Interaction Effects Between Higher Order Branding Constructs. In V. Esposito Vinzi, W. W. Chin, J. Henseler, & H. Wang (Eds.), *Handbook of Partial Least Squares*, 621-652, Springer Berlin Heidelberg.