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## A note on "trade-off and compatibility between performance: definitions and empirical evidence"

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4 **A note on “trade-off and compatibility between**  
5 **performance: definitions and empirical evidence”**  
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## **A note on “trade-off and compatibility between performance: definitions and empirical evidence”**

**Abstract:** This paper improves on a novel methodology advanced in order to assess deterministically (i.e.; precisely) compromises and compatibilities between manufacturing capabilities in individual firms. We extend the original proposal to include more recent theoretical developments arguing that both trade-offs and compatibilities (e.g.; cumulative capabilities) can be observed in a relationship between two or more competitive criteria. This means that as opposed to widely-accepted views, trade-offs and compatibilities can be complementary, and not necessarily mutually exclusive, when explaining relationships between various competitive criteria. As such, our improved methodology and rationale can assess the existence of both trade-offs and compatibilities between multiple capabilities utilising a single framework. Opportunities for novel research that uses our methodology are also offered.

**Keywords:** *trade-off model, cumulative capabilities model, compatibilities, deterministic analyses, probabilistic analyses.*

# **A note on “trade-off and compatibility between performance: definitions and empirical evidence”**

## **1 Introduction**

The question of whether a firm can achieve market-leading performance across a number of competitive criteria (e.g.; delivery, quality, flexibility) has been a topic of considerable interest in the field of strategic/operations management. The seminal works by Skinner (1969; 1974) have inspired a growing number of investigations that have looked at different aspects of what has been termed as the “trade-off model”. Over the years, research on this and related topics (e.g.; Ferdows and de Meyer, 1990; Schmenner and Swink, 1998; Safizadeh et al, 2000; da Silveira and Slack, 2001; Corbett and Claridge, 2002; da Silveira, 2005; Narasimhan et al, 2005; Miltenburg, 2008) have resulted in new advances and in a better understanding of the different aspects involved in the attainment of high levels of performance by manufacturing/service firms.

A key issue in this theme is the methodologies and rationales by which investigators come to the conclusion that two or more competitive criteria are in a trade-off and/or a compatibility (e.g.; cumulative capability) relationship. Recent literature reviews (Rosenzweig and Easton, 2010; Sarmiento et al, 2010) show that quantitative studies using probabilistic methodologies, rationales and estimates based on statistics are a preferred approach in this line of research. Analysts have usually relied on linear regression/correlation analysis and related methodologies (e.g.; path analysis) to determine trade-offs/cumulative capabilities between different pairs of competitive criteria. For example, “a positive significant coefficient indicates a cumulative capability, while a negative significant coefficient indicates a trade-off” (Flynn and Flynn, 2004, p. 446).

General, overall and probabilistic approaches to the study of these themes are important. Nevertheless, the literature is almost void of approaches that can be used to assert the presence of trade-offs/compatibilities between multiple

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3 capabilities when a single firm is the unit of analysis. Filippini et al (1998) attempt  
4 to address this issue by offering a novel methodology and rationale. Their  
5 investigation, however, still views trade-offs and compatibilities as belonging to  
6 two separate and distinct frameworks.  
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12 Contrary to commonly-held views, more recent developments (e.g.;  
13 Skinner, 1992; Schmenner and Swink, 1998) argue that trade-offs and  
14 compatibilities are not necessarily mutually exclusive concepts that belong to  
15 different frameworks. Also, Sarmiento (2009) shows that the main principle of the  
16 trade-off model rests on the analysis of whether individual and identifiable firms  
17 can achieve market-leading level of performance across multiple competitive  
18 criteria. Therefore, based on these recent investigations, we try to build on  
19 Filippini et al's (1998) work by proposing an improved rationale and methodology  
20 by which the trade-offs and compatibilities concepts are unified under a single  
21 framework when individual firms are the units of analysis.  
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32 The rest of the paper is organized as follows: section 2 presents various  
33 definitions, clarifications and background necessary for the investigation. Section  
34 3 details our new methodology and also includes several illustrative examples.  
35 Finally, section 4 offers some conclusions and venues for future research.  
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## 41 **2 Trade-offs and compatibilities: definitions,** 42 **clarifications and background** 43 44 45 46

47 Filippini et al's (1998) investigation offers an important departure from  
48 previous research. Their study, contrary to widely-used quantitative and  
49 probabilistic methods, is the first attempt to establish the existence of trade-offs  
50 and compatibilities by means of a deterministic approach using single firms as  
51 the units of analysis. They base their methodology on an assessment of the  
52 actual levels of performance attained by individual firms across various  
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3 capabilities. Common levels of performance, as well as differentials, are  
4 analyzed, and the existence of compatibilities and trade-offs are thus asserted.  
5 Nonetheless, their methodology still considers trade-offs and compatibilities as  
6 belonging to two different frameworks and relationships. As such, it does not take  
7 into account newer developments that contradict those long-held views. To  
8 understand the limitations of their approach and hence the way it can be  
9 improved, we quote various definitions that Filippini et al utilize, and a brief  
10 reexamination of such statements follows:  
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19 “...the underpinning concept is that in a trade-off situation, high-levels of  
20 performance over several performance types are not reached.  
21 Compatibility should be seen as the possibility of achieving high values  
22 over several types of performance”. (Filippini et al, 1998, p. 3383).  
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28 **Clarification 1:** While it is true that the underlying fundament of the  
29 cumulative capabilities (e.g.; compatibilities) model is that of the achievement of  
30 high levels of performance across several competitive criteria, the core principle  
31 behind the trade-off model states that no manufacturing system can attain an  
32 industry-leading type of achievement along all performance types. As Skinner  
33 (1996, p. 6) writes: “... one system cannot be outstanding enough at meeting all  
34 criteria to create competitive advantage”. Also, “(T)o ever assume that a plant or  
35 service operation can function without trade-offs is absurd” (Skinner, 1992, p.  
36 20). The preceding statements imply that, to truly be a competing concept to  
37 Skinner’s, the cumulative capabilities model should aim at explaining how firms  
38 can achieve industry-leading performance across all capabilities, since the trade-  
39 off model denies that possibility. Put differently, firms could very well achieve  
40 excellent, high levels of performance in three, four or more capabilities. But as  
41 long as they are not able to attain that type of achievement along all criteria, the  
42 trade-off concept will not be refuted (Note: Skinner initially proposed seven  
43 performance criteria by which a manufacturing system should be assessed.  
44 Nevertheless, this should not be seen as a static and unchanging set. For  
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example, new criteria could be added due to market forces and/or new technologies. See Skinner, 1992, 1996, for a more detailed discussion).

“It can therefore be said that two types of performance are in trade-off if the achievement of high values in one type of performance means low values in another. A trade-off situation is characterized, therefore, by high levels of difference between the two types of performance”. (Filippini et al, 1998, p. 3383).

**Clarification 2:** Skinner (1992) defines a trade-off situation as one in which a high, industry-leading level of performance in one capability is attained at the expense of lesser (and not necessarily “low”) levels of achievement in one or more performance types. The difference between Skinner’s and Filippini et al’s definitions of a compromised relationship is subtle, but important. By Skinner’s definition, the gap in performance between two capabilities that are compromised need not be high, as Filippini et al propose. The difference only needs to be noticeable enough so that a gap in competitive power between the two capabilities can be distinguished. This will be fully explained in section 3.

“On the other hand, it can be said that two types of performance are compatible if both have high values. A situation of compatibility is characterized, therefore, by low value difference between performance types and by the presence of high values in general”. (Filippini et al, 1998, p. 3383).

**Clarification 3:** As commented before, a gap in performance between two capabilities can also be explained as a trade-off situation, even if the difference is low. As long as the gap is distinguishable enough so that a differential in competitive power can be observed between two capabilities, it can be validly deemed as a compromised relationship. In light of this, a compatibility situation can only be considered as such when two or more capabilities observe common



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3 levels of performance. Such a compatibility can be seen at the lower, in-between  
4 and high/industry-leading levels of achievement. This will be further clarified in  
5 section 3.  
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10 Another key and underlying point concerns the main focus of the trade-off  
11 concept. While an assessment and analysis of general trends and commonalities  
12 (e.g.; significant and positive correlation coefficients) are important, the validity of  
13 the trade-off model rests on an analysis of whether individual and identifiable  
14 firms can attain market-leading performance across multiple, and eventually all,  
15 competitive criteria. This can be derived from statements such as "... one system  
16 cannot be outstanding enough at meeting all criteria to create competitive  
17 advantage" (Skinner, 1996, p. 6).  
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26 We now discuss briefly key concepts and research that support our  
27 investigation. Although Skinner (1992) had already considered the possibility that  
28 compatibilities and trade-offs could explain more fully the relationships between  
29 two or more competitive criteria, it is Schmenner and Swink (1998) who formally  
30 attempt to integrate the two apparently competing concepts into a single  
31 framework. Their theory of performance frontiers gives a new light into the nature  
32 of compatibility and trade-off relationships between several criteria. In short, they  
33 suggest that while it is possible for a firm to achieve compatibilities (e.g.;  
34 cumulative capabilities) up to a certain level across several performance metrics,  
35 structural factors will impede the achievement of a high, industry-leading type of  
36 performance in all of them, something which is consistent with the underlying  
37 principle of the trade-off model explained before. More recently, Sarmiento  
38 (2009), utilizing Karl Popper's falsificationism (Popper, 2002 a & b),  
39 demonstrates that the trade-off model is a plausibly falsifiable concept<sup>1</sup>. As such,  
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55 <sup>1</sup> The trade-off model is presented in a similar (if not identical) way to that of the natural laws, as it negates  
56 the existence of a single firm that is capable of achieving industry-leading performance across all  
57 competitive criteria. This means that the trade-off model is a plausibly falsifiable concept. See Sarmiento  
58 (2009), and Popper (2002a, p. 48) for more details.  
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3 it can also envelop probabilistic and deterministic theories, hypotheses,  
4 estimates, statements, cumulative capabilities, compatibilities, etc.  
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9 To sum up, our investigation borrows from recent developments in this line of  
10 research. For example, from works such as Skinner (1992) and Schmenner and Swink  
11 (1998) we know that, as opposed to widely-held views, compatibilities (e.g.; cumulative  
12 capabilities) and trade-offs are two concepts that can be integrated under a single  
13 framework and relationship. From Sarmiento (2009), we understand that the trade-off  
14 model is a plausibly falsifiable (i.e.; deterministic/precise) concept. Its main premise rests  
15 on the analysis of whether identifiable and observable firms can achieve excellent levels  
16 of performance across a number of capabilities. As such, to estimate the validity of the  
17 trade-off model, a researcher necessitates a framework that can guide her/him in the  
18 analysis of individual firms in order to make assessments regarding the existence of  
19 trade-offs and/or compatibilities between multiple competitive criteria. Filippini et al  
20 (1998) attempted to offer such a framework. Nonetheless, their methodology has some  
21 deficiencies that stem mainly from the fact that they do not consider trade-  
22 offs/compatibilities as belonging to the same framework and relationship.  
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33 In the next section, we attempt to improve on Filippini et al's (1998)  
34 methodology. Specifically, we will modify it using the concepts by Skinner (1992) and  
35 Schmenner and Swink (1998), and also the work by Sarmiento (2009) (e.g.; footnote2).  
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### 40 **3 A methodology and illustrative examples**

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42 To explain our arguments, we utilize the figures by Filippini et al with their  
43 original interpretation. We then offer alternative understandings and conclusions  
44 using an improved methodology based on the more recent theoretical  
45 developments and clarifications discussed in section 2.  
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**Take in figure 1**

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**Take in figure 2**

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Filippini et al divide the different levels of performance into four categories (i.e.; quartiles). Since they are dealing with the trade-off model, and given that this concept is discussed principally within a competitive context, it is reasonable to assume that the “top quartile” represents an industry-leading type of performance, with the rest of the categories representing lesser levels of achievement. In fact, Filippini et al write that “(I)n order to verify if it is possible to excel in different performance types simultaneously, the levels of compatibility between performance are measured” (p. 3391).

The two columns that are divided into quartiles represent any two manufacturing capabilities (e.g.; quality, cost), while the black dots represent the various positions a firm can achieve along these performance types. Filippini et al characterize as “strong” those situations in which the two performance metrics are placed at the “top quartile” levels in the case of compatibilities, and at the “top quartile” and “bottom quartile” levels in terms of trade-offs. The rest of the situations are explained as “general”. It is also noted that, consistent with previous investigations, Filippini et al also understand trade-offs and compatibilities (e.g.; cumulative capabilities) as belonging to different frameworks and situations. This is reflected in the scenarios depicted in figure 1, which are excluded from figure 2, and vice versa.

We now move on to improve on Filippini et al’s approach. First of all, we delineate a methodology by which the presence of compatibilities/trade-offs between pairs of competitive criteria can be asserted:

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Stage 1: Collect information regarding the performance along competitive criteria (e.g.; “quality” and “cost”) of an individual and identifiable firm (e.g.; firm “X”). If there is evidence of an industry-leading type of performance in at least one competitive criterion, go to stage 2. If there is no evidence of a market-leading level of achievement in any of the criteria, no statement regarding the existence of trade-offs between them can be made<sup>2</sup>

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Stage 2: Compare the performance of firm “X” along a pair of competitive criteria (e.g.; cost and quality). If both capabilities observe “industry-leading” type of performance, it can be asserted that no trade-offs exist, because no gap with respect to market-leading type of performance between the criteria is observed. This means that firm “X” was capable of attaining best-in-industry type of performance in one competitive criterion (e.g.; quality) without causing a decrease in achievement in the other one (e.g.; cost). If one of the criteria observes “less-than-industry-leading” type of performance, go to stage 3.

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Stage 3: When one competitive criterion observes market-leading performance and the other one does not, it can be asserted plausibly that there is a trade-off between the two criteria. This is because a trade-off signifies a difference in competitive power between multiple capabilities. Thus, it could be argued that the observed gap in achievement could be the result of a compromised relationship between the two criteria. This is consistent with Skinner’s definition of a trade-off situation (1992). Moreover, common levels of performance between the criteria could also be assessed.

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It can be seen that all the situations included in Filippini et al’s two frameworks can be also described using our new methodology. We now offer

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<sup>2</sup> A trade-off relationship between two capabilities implies the achievement of a market-leading level of performance in one of them (e.g.; quality) at the expense of lower levels in the other one (e.g.; cost). Thus, when neither of the analysed capabilities has achieved an excellent type of performance, it is impossible/illogical to assert the presence of a trade-off relationship between the two competitive criteria. Nevertheless, we think that assessments regarding potential compatibilities (i.e.; common levels of performance) between the two capabilities could still be made.

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3 various illustrative cases showing how the presence of trade-offs and/or  
4 compatibilities can be assessed using a single framework. For example, let us  
5 imagine a manufacturing system (e.g.; firm “X”) that observes an “upper quartile”  
6 level of achievement in one capability and a “top quartile” type of performance in  
7 the other capability (e.g.; **any and all of the 35 firms identified in Filippini et**  
8 **al’s figure 3, p. 3393**). This would represent a “general compatibility” relationship  
9 (figure 1) as represented by the diagonal and dotted line connecting a top  
10 quartile with the upper quartile in the opposite column.  
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19 Using our improved methodology, the “general compatibility” situation can  
20 be described as one in which firm “X” achieved compatibilities between the two  
21 performance types up to the “upper quartile” level, and that a trade-off with  
22 respect to the “top quartile” level of achievement (i.e.; a gap in performance  
23 representing a differential in competitive power) is also observed. As explained  
24 before, for a trade-off to be deemed as such, the difference in performance  
25 between two capabilities does not need to be “high”. Thus, in our improved  
26 methodology and rationale, levels of compatibilities and differences with respect  
27 to the achievement of an industry-leading type of performance are  
28 acknowledged. Figure 3 illustrates our proposal.  
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**Take in figure 3**

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Let us imagine another hypothetical case (e.g.; firm “Y”) that observes a  
“strong compatibility” scenario between the two competitive criteria (e.g.; **any**  
**and all of the 15 firms identified in Filippini et al’s figure 3, p. 3393**). This is  
represented in figure 1 by the continuous and horizontal line connecting the two  
top quartiles. This relationship would also fit perfectly within our new approach.  
Nevertheless, as opposed to the “general compatibility” case explained before, in  
the “strong compatibility” situation, no trade-offs between the two capabilities can

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4 be established, as no distinguishable differentials in performance exist. Figure 4  
5 exemplifies this situation:  
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**Take in figure 4**

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A third hypothetical scenario (e.g.; firm “Z”) can be used to show that the cases included in Filippini et al’s figure 2 can also be explained in light of our new proposal. For example, when one of the performance types is situated at the “top quartile” level, and the other one is at the “lower quartile” level (i.e.; a “general trade-off” situation shown in figure 2 represented by a dotted and diagonal line), we propose to reinterpret it as a scenario in which firm “Z” observes a compatibility at the “lower quartile” level between the two performance types, and also a trade-off with respect to the “top quartile” level of achievement, as there is a distinguishable gap in performance between the two capabilities. Figure 5 shows this:

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**Take in figure 5**

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From our proposed methodology and the above examples, it is evident that the only scenario in which it is possible to state that no trade-off is present is when the two performance types are situated at the “top quartile” level at the same time. In all other cases, varying combinations of both trade-offs and/or compatibilities can be asserted. This is also consistent with the results by Sarmiento (2009). Our improved methodology can also utilize likert-type scales. These instruments are widely-used by researchers to collect information in survey-based studies. In those investigations, respondents are usually asked to perceptually assess their firm’s performance across various capabilities (e.g.; delivery, flexibility, cost) compared to their competitors using a 5 or a 7 point-scale. The upper end of the scale normally describes the highest level of

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3 performance (e.g.; 5= “our delivery performance is the best in industry”), while  
4 the rest of the points in the scale (e.g.; 4, 3, 2, 1) represent lesser levels of  
5 achievement.  
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10 Like Filippini et al’s methodology, our new approach can also be applied to  
11 cases in which more than two performance types are included. Using a 5 point  
12 likert-type scale, let us suppose that a firm observes a “5” and “5” levels of  
13 achievement along “cost” and “quality”, a “4” level of performance in “flexibility”,  
14 and a “3” level of achievement in “delivery”. We would interpret the observed  
15 scenario as a firm that exhibits no trade-offs between “cost” and “quality”. We  
16 would also say that compatibilities are observed up to the “3” level of  
17 achievement across the analyzed capabilities, a level after which there are  
18 distinguishable and varying differences in performance between some  
19 capabilities (e.g.; cost and flexibility), something which signals the presence of  
20 trade-offs amongst various competitive criteria.  
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#### 32 **4 Conclusions and venues for future research**

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36 Filippini et al’s (1998) novel methodology aids a researcher to assert in a  
37 deterministic (i.e.; precise) manner the presence of compatibilities and trade-offs  
38 between two or more capabilities in individual firms. Their work offers a different  
39 perspective from the widely-used quantitative and probabilistic approaches  
40 utilized in research that investigates whether a firm is capable of achieving an  
41 industry-leading type of performance across several capabilities. By taking into  
42 consideration more recent theoretical developments, we have tried to improve on  
43 their original approach.  
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52 We think that there are opportunities for future research using our  
53 proposed methodology. For example, as recent literature reviews (Sarmiento et  
54 al, 2010, Rosenzweig and Easton, 2010) demonstrate, the study of trade-offs  
55 and compatibilities has been dominated by quantitative investigations  
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3 concentrating on general trends in samples of firms (e.g.; the estimation of trade-  
4 offs/cumulative capabilities using linear regression/correlation analysis).  
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6 Relatively very few research (e.g.; case studies) focusing on individual firms have  
7 been performed thus far. In our view, this means there is a particular need for  
8 studies that take individual firms as the unit of analysis in order to investigate the  
9 potential existence of trade-offs and compatibilities. By integrating newer  
10 theoretical developments into Filippini et al's (1998) pioneering work, we have  
11 provided researchers with a tool that can help them to determine the presence of  
12 trade-offs/compatibilities when individual firms are the units of analysis. We hope  
13 future investigators will integrate our framework into their studies of the trade-off  
14 model and related concepts.  
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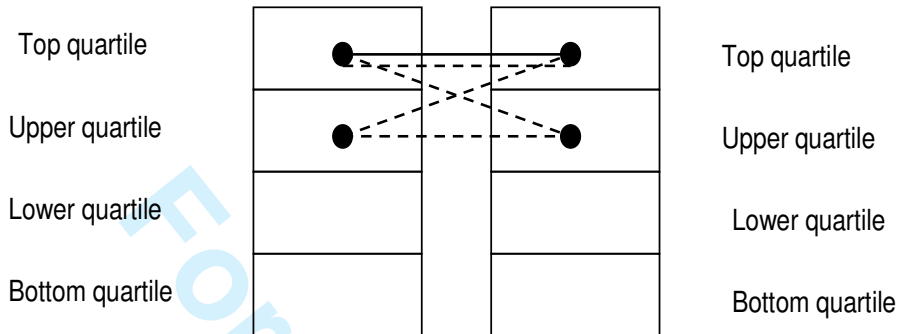
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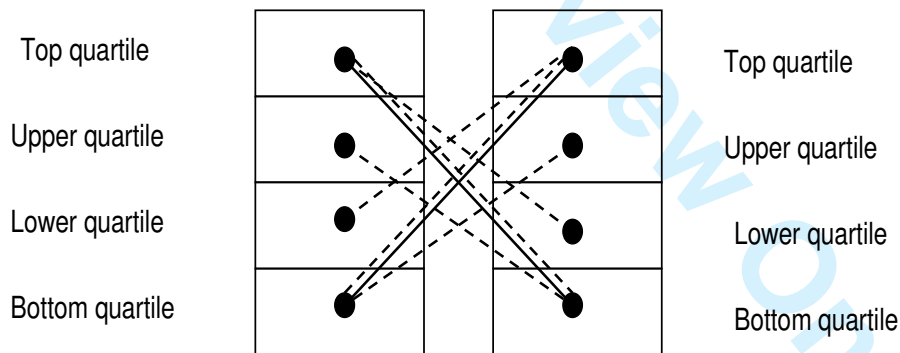
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**Figures**



**Figure 1. Compatibility situations** ( — strong definition, - - - - - general definition)  
(adapted from Filippini et al, 1998)



**Figure 2. Trade-off situations** ( — strong definition, - - - - - general definition)  
(adapted from Filippini et al, 1998)

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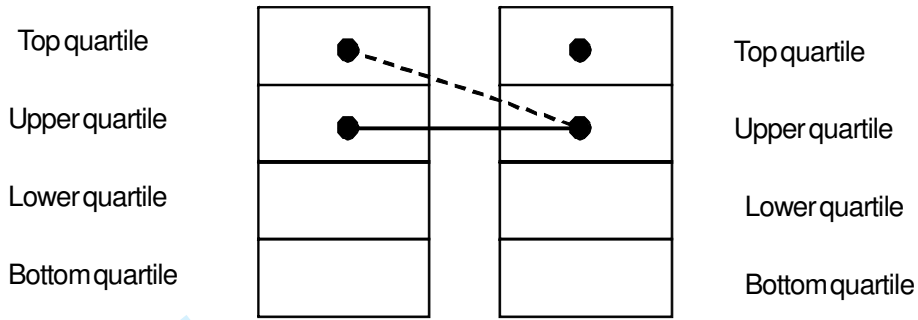


Figure 3. Compatibility and trade-off situations ( ——— compatibility, - - - - - trade-off)

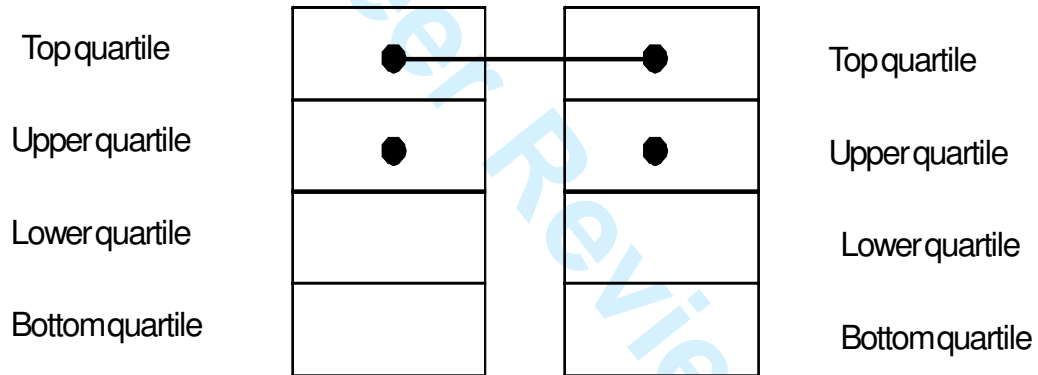


Figure 4. Compatibility situation ( ——— ) with no observed trade-off

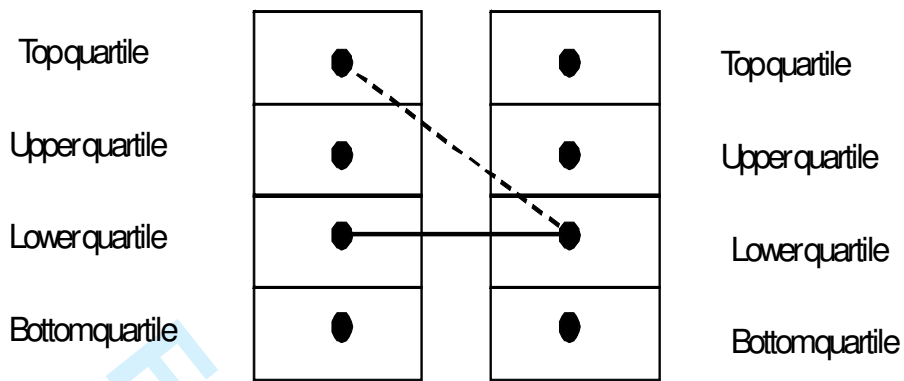


Figure 5. Compatibility and trade-off situations ( — compatibility, - - - - - trade-off)