Environmental and Cost Synergy in Supply Chain Network Integration in Mergers and Acquisitions

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Paper Outline

- We focus on the case of supply chain integration through horizontal mergers (or acquisitions) and extend the contributions in Nagurney (2008) to include multicriteria decision-making and environmental concerns.
- Construct a measure to evaluate the anticipated synergy
  - Operational (cost)
  - Environmental
- We analyze the relationship between cost and environmental synergy in numerical examples.
- The framework is based on a supply chain network perspective, in a system-optimization context.

Topics

- Acknowledgements
- Motivation
- Literature Review
- The Supply Chain Integration Models
- Synergy Measures
- Numerical Examples
- Research Directions

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Consumer Pressures

- **67%** of Americans agree that "even in tough economic times, it is important to purchase products with social and environmental benefits," and half (**51%**) say they are "willing to pay more" for them*.
- BBMG found that **77%** of Americans agree that they "can make a positive difference by purchasing products from socially or environmentally responsible companies*.
- **72%** of Americans stated they would ‘punish’ polluters in the marketplace that violate environmental rules, also called a “reputational penalty”, i.e., not purchasing products from companies whose practices they disagree with to “punish” the firm.
- Environmentally Preferable Purchasing (EPP) Program.

PepsiCo determined that the carbon footprint of its half-gallon carton of Tropicana Pure Premium Orange Juice is 3.75 pounds of carbon dioxide. *(Photo: Chip Litherland for The New York Times)*

* *2009 BBMG Conscious Consumer Report*

Current Merger & Acquisition Activity

- M&A totaled over $2 trillion in 2009, down 32 percent from full-year 2008 and down 53 percent from the record high in 2007, according to data from Thomson Reuters.
- Mergers announced in October 2010 include Bain Capital/Gymboree, at $1.789 billion and Dynamex/Greenbriar Equity Group ($207 million).
- Global 2010 M&A activity is estimated to rise as much as 35 percent from 2009 figures (Sanford C. Bernstein research firm)

Source: OECD

Merger Activity

- The number of bankruptcy-related mergers and acquisitions had risen to 241 through just August of 2009, a **65%** increase over the same time in 2008, according to Thomson Reuters data.
- The stocks of 53 companies that made the biggest purchases from 2005 to 2008 lagged behind industry peers 2 years later (Bloomberg). Among the worst performers were Sacramento's McClatchy Co., Boston Scientific Corp., and Sprint Nextel Corp., all three of which are now valued at less than the price they paid for their acquisitions.
- Successful mergers can add tremendous value; however, the failure rate is estimated to be between 74% and 83% (Devero (2004)).
- It is worthwhile to develop tools to better predict the associated strategic gains, which include, among others, cost savings (Eccles, Lanes, and Wilson (1999)).
- A successful merger depends on the ability to measure the anticipated synergy of the proposed merger (cf. Chang (1988)).

Developing Countries and the Environment

- Example of 2010 M&A deals that included foreign buyers: gold industry, Capital Gold/Gammon ($271 million), and identity software, Actividentity/Assa Abloy ($153 million).
- There is enormous potential for developing countries to adopt cleaner production, given current technologies as well as the levels of private capital investments.
- For example, between 1988-1995, multinational corporations invested nearly $422 billion worth of new factories, supplies, and equipment in these countries (World Resources Institute (1998)).
- Through globalization, firms of industrialized nations can acquire those firms in developing nations that offer lower production costs; however, more than not, combined with inferior environmental concerns.
- The actions taken today will greatly influence the future scale of environmental and health problems.

Supply Chain Integration

- “The real competition is not company against company but supply chain against supply chain” (Albino, Izzo, and Uhtz (2002))
- Coordination of the supply chain can improve competitiveness and efficiency at the channel level rather than at the firm level.

User-Optimization vs System-Optimization

User-Optimization

- Non-cooperation
- Individuals seek to minimize their own cost.
- Although optimal from each traveler's perspective, it may not be optimal from a societal one.

System-Optimization

- Cooperation
- A central controller seeks to minimize the total cost throughout the network.
- Although optimal from a societal one, it may not be optimal from a traveler's perspective.
- This solution will always be the same or better than the U-O solution.

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Relevant Literatures

- Farrell and Shapiro (1990), Spector (2003), Farrel and Shapiro (2001), Soylu et al. (2006), Xu (2007))
- Nagurney (2008) developed a system optimization perspective for supply chain network integration in the case of horizontal mergers.
- According to Stanwick and Stanwick (2002), if environmental issues are ignored the value of the proposed merger can be greatly compromised.
- Lambertini and Mantovani (2007) conclude that horizontal mergers can contribute to reduce negative externalities related to the environment.

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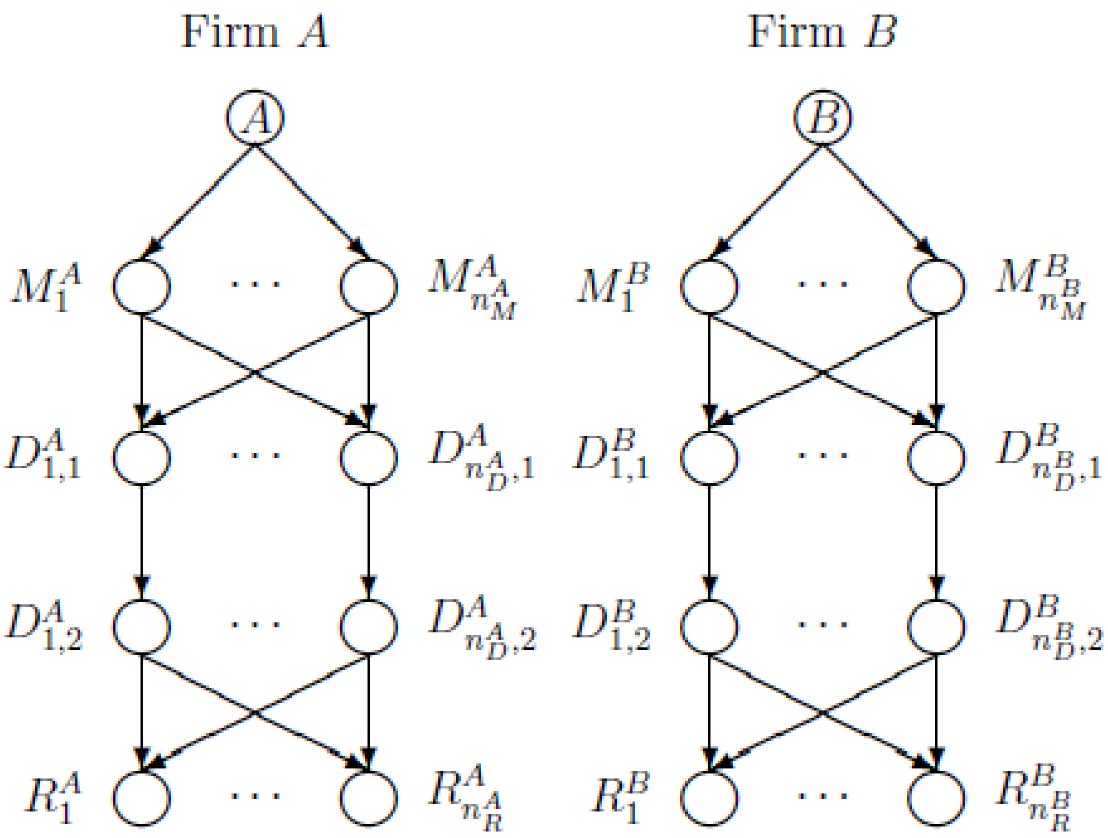
Supply Chain Network of Firms A and B Prior to the Merger: Case 0



Supply Chain Network of Firms A and B Prior to the Merger: Case 0

We assume that each firm provides a homogenous product to the meet the demand at each retail market, R^i_k. The demand, $d_{R^i_k}$, is assumed fixed and given for each retail market associated with firm, $i=A,B$.

Let L_0 denote the links: $L_A \cup L_B$

A path, p, consists of a sequence of supply chain activities comprising supply/manufacturing, storage, and distribution of the product.

Let x_p denote the nonnegative flow of the product on path p.

Since we are first considering the two firms prior to any merger/integration, the paths associated with a given organization have no links in common with the paths of the other firm. This changes when the merger occurs, as the number of paths, and set and number of links changes.

Supply Chain Network of Firms A and B Prior to the Merger: Case 0

The following conservation of flow equations must hold for each firm *i*:

$$\sum_{p \in P^0_{R^i_k}} x_p = d_{R^i_k}, \quad i = A, B; k = 1, \ldots, n^i_R,$$

where $P^0_{R^i_k}$ denotes the set of paths connecting (origin) node *i* with (destination) retail node R^i_k.

One must also have the following conservation of flow equations satisfied:

$$f_a = \sum_{p \in P^0} x_p \delta_{ap} \quad \forall a \in L^0,$$

Where P^0 denotes the set of *all* paths, that is, $P^0 = \cup_{i=A,B;k=1,\ldots,n^i_r} P^0_{R^i_k}$

Supply Chain Network of Firms A and B Prior to the Merger: Case 0

The path flows must be non-negative, that is,

$$x_p \geq 0, \quad \forall p \in P^0$$

The total cost on a link is assumed to be a function of the flow of the product on the link:

$$\hat{c}_a = \hat{c}_a(f_a), \quad \forall a \in L^0.$$

The total emissions on a link is assumed to be a function of the flow of the product on the link:

$$e_a = e_a(f_a), \quad \forall a \in L^0.$$

These costs are assumed convex, continuously differentiable, and have a bounded second order partial derivative.

Supply Chain Network of Firms A and B Prior to the Merger: Case 0

The multicriteria decision-making optimization problem for the pre-merger case, can be expressed as follows:

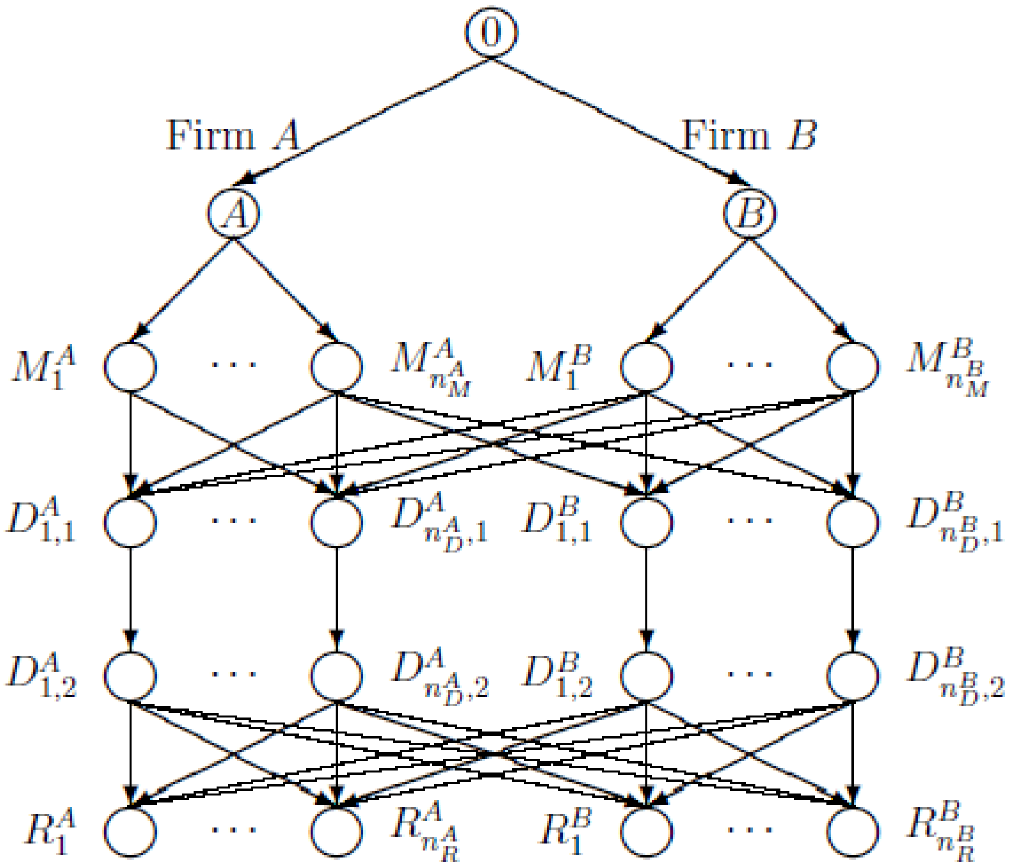
$$Minimize \sum_{a \in L^0} \sum_{i=A,B} \hat{c}_a(f_a) + \alpha_{ia} e_a(f_a).$$

subject to the constraints presented earlier and

$$f_a \leq u_a, \quad \forall a \in L^0.$$

α_{ia} stands for a nonnegative constant assigned to the emissions-generation criterion for firms $i = A,B$ and links a ϵ L_i . For simplicity, $\alpha_{ia} \equiv 0$ if link $a \notin L_i$ and $\alpha_{ia} \equiv \alpha_i$. α_{ia} can be assumed the price that each firm, i , would be willing to pay for each unit of emission. Thus, α_{ia} , represents the weight of the environmental concern for each firm, i , and a higher α_{ia} represents a greater concern for the environment.

Supply Chain Network of Firms A and B Post the Merger: Case 1



Supply Chain Network of Firms A and B Post the Merger: Case 1

Let L_1 denote the links: $L_A \bigcup L_B$

We associate total cost and total emission functions with the new links; for simplicity, the costs on the links emanating from the supersource node are equal to zero.

A path, p, now originates at node *0* and is destined for one of the bottom demand nodes.

The multicriteria decision-making optimization problem for the post-merger case, can be expressed as follows:

$$Minimize \sum_{a \in L^1} \sum_{i=A,B} \hat{c}_a(f_a) + \alpha e_a(f_a).$$

Supply Chain Network of Firms A and B Post the Merger: Case 1

The firms, pre-merger, assigned a weight representing their individual environmental concerns; post-merger, the weight was uniform and non-negative, representing a single decision-making economic entity.

α can be assumed the price that the firm would be willing to pay for each unit of emission, representing the weight of environmental concern; a higher α represents a greater concern for the environment.

There are distinct options for the weight and we explore several in concrete numerical examples:

- Specifically, in the case that the merger is amicable, with being a function of the firms' pre-merger weights.
- In the case that the merger is hostile, with the value of being that of the dominant firm in the merger.

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Synergy Measures

- We define the total generalized cost TGC^0 associated with the pre-merger problem, or Case *0* as the value of the pre-merger objective function evaluated at its optimal solution f^{*0}.

- We define the total generalized cost TGC^1 associated with the post-merger problem, or Case *1* as the value of the post-merger objective function evaluated at its optimal solution f^{*1}.

The synergy associated with the total generalized costs which captures both the total costs and the weighted total emissions is denoted by S^{TGC} and is defined as follows:

$$S^{TGC} \equiv \left[\frac{TGC^0 - TGC^1}{TGC^0} \right] \times 100\%$$

Synergy Measures

- We define TC^0 as the total costs generated under solution f^{*0}.
- We define TC^1 as the total costs generated under solution f^{*1}.

The synergy associated with the total costs pre and post the merger (cf. Eccles et al. (1999), Nagurney (2008), but not associated with the multicriteria decision-making context, which is denoted by S^{TC} is defined as follows:

$$S^{TC} \equiv \left[\frac{TC^0 - TC^1}{TC^0} \right] \times 100\%$$

- We define TE^0 as the total emissions generated under solution f^{*0}.
- We define TE^1 as the total emissions generated under solution f^{*1}.

The synergy associated with the total emissions pre and post the merger, but not associated with the multicriteria decision-making context, which is denoted by S^{TE} is defined as follows:

$$S^{TE} \equiv \left[\frac{TE^0 - TE^1}{TE^0} \right] \times 100\%$$

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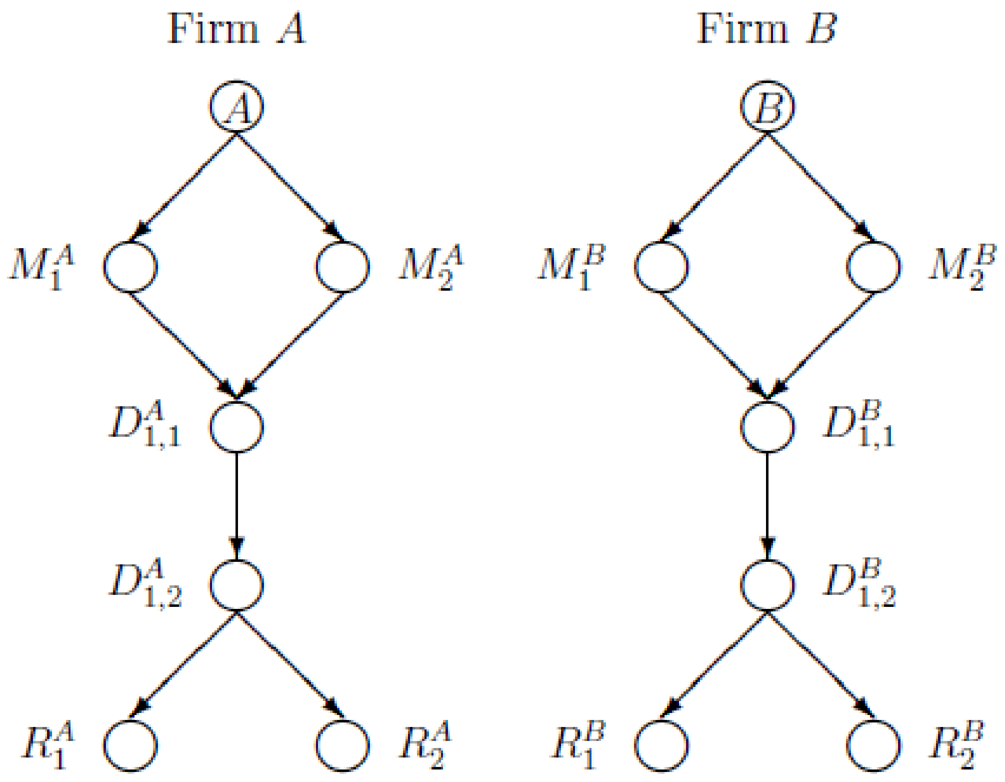
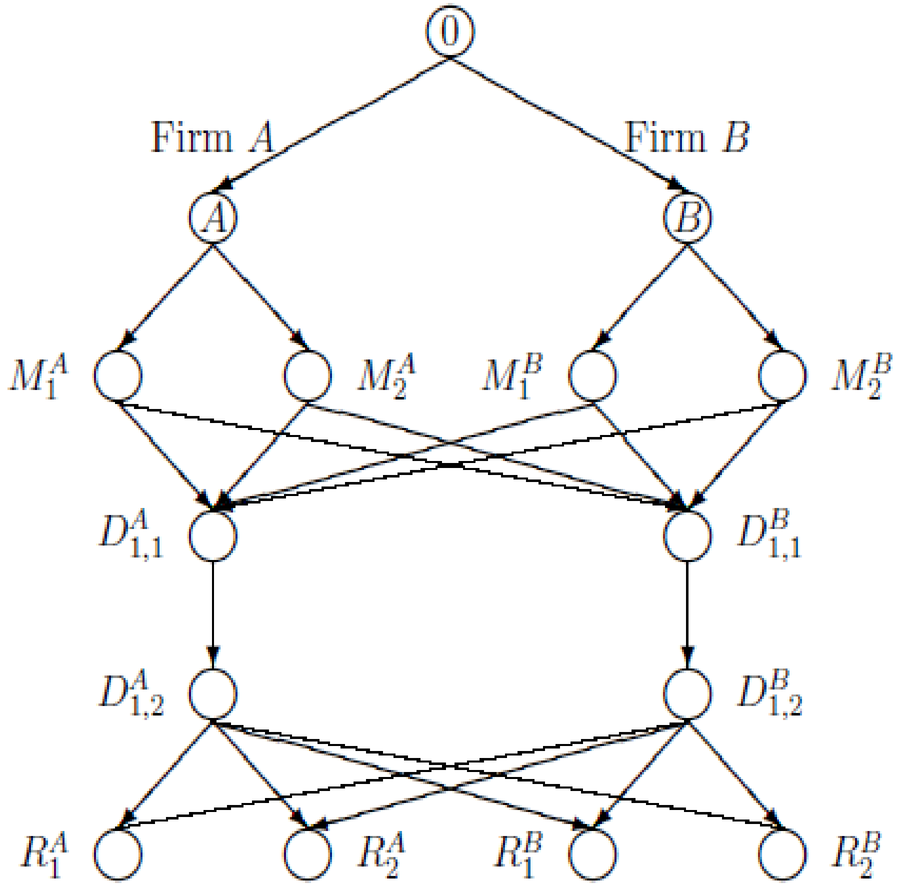
Pre-Merger Supply Chain Network Topology for the Numerical Examples



Post-Merger Supply Chain Network Topology for the Numerical Examples



Numerical Examples

- Capacity on each link initially set to 15.
- The individual pre-merger weights as well as the uniform post-merger weights were set to 1.
- The total cost functions on all links (except those emanating from the supersource node) were represented by:

$$\hat{c}_a(f_a) = f_a^2 + 2f_a$$

- The total emission functions on all links (except those emanating from the supersource node) were represented by:

$$e_a(f_a) = 10f_a$$

Solution to the Numerical Examples

Example	1	2	3	4
TC^0	660.00	660.00	660.00	660.00
TC^1	560.00	566.22	560.00	560.00
S^{TC}	*15.15%*	*14.21%*	*15.15%*	*15.15%*
TE^0	800.00	600.00	600.00	800.00
TE^1	800.00	574.98	600.00	800.00
S^{TE}	*0.00%*	*4.23%*	*0.00%*	*0.00%*
TGC^0	1460.00	860.00	860.00	1060.00
TGC^1	1360.00	853.71	560.00	1360.00
S^{TGC}	*6.85%*	*0.73%*	*34.88%*	*-28.30%*

Solutions to the Variant Numerical Examples

Example	1	2	3	4
TC^0	660.00	660.00	660.00	660.00
TC^1	660.00	578.46	560.00	660.00
S^{TC}	*0.00%*	*12.35%*	*15.15%*	*0.00%*
TE^0	800.00	600.00	600.00	800.00
TE^1	400.00	376.03	600.00	400.00
S^{TE}	*50.00%*	*37.33%*	*0.00%*	*50.00%*
TGC^0	1460.00	860.00	860.00	1060.00
TGC^1	1060.00	766.47	560.00	1060.00
S^{TGC}	*27.40%*	*10.88%*	*34.88%*	*0.00%*

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Research Directions

- Anna Nagurney (2010) Formulation and Analysis of Horizontal Mergers Among Oligopolistic Firms with Insights into the Merger Paradox: A Supply Chain Network Perspective., *Computational Management Science,* 7, pp 377-401.

- Extend on the paper, "*Environmental and Cost Synergy in Supply Chain Network Integration in Mergers and Acquisitions*" to include multiple products and multiple firms to further the understanding of the market and environmental effects resulting from isolated mergers/integration with computational results.

- Study and implement policy implications on resulting emissions and associated effects on horizontal mergers/acquisitions.

Thank you!

http://supernet.som.umass.edu/