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journal homepage: www.elsevier.com/locate/ijpeOperational hedging strategies and competitive exposure to exchange rates [☆]Lingxiu Dong ^{a,1}, Panos Kouvelis ^{a,1}, Ping Su ^{b,*}^a Olin Business School, Washington University in St. Louis, Campus Box 1133, St. Louis, MO 63130-4899, USA^b Department of Management, Entrepreneurship & General Business, Hofstra University, Hempstead, NY 11549, USA

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ABSTRACT

This paper investigates the impact of operational flexibility on firms' economic exposure to currency fluctuations in the presence of global competition. We consider a global firm who sells as a monopolist in the domestic market, and also sells to a foreign market facing competition from a local competitor of certain capacity. We compare the effects of two operational strategies of the global firm, namely, matching currency footprints ("natural hedge") and the capacity pooling strategy with allocation flexibility. For a two-stage stochastic model, we derive the optimal capacity and selling decisions for the global firm, and from the comparative statics analysis of our model we infer useful managerial insights. (1) We find that operational flexibility enables the global firm to exploit the possible high exchange rate (i.e., devalued home currency) realizations for profit improvement, and thus increases in the long run the firm's expected profit. (2) Furthermore, operational flexibility allows for downside risk control as the exchange rate becomes more volatile, since the resource pooling option cleverly exercised minimizes the impact of unfavorable currency realizations. (3) The global firm's operational flexibility increases its competitor's downside risk, but may also benefit the competitor's expected profit since a flexible global firm may decide not to compete when the exchange rate is not favorable. In conclusion, our paper substantiates that "natural hedge" is not effective from a profit maximization perspective. We clearly illustrate the robust profit maximizing performance and reasonable downside risk control of operational hedging approaches, which rely on the clever exercising of operational flexibility options such as resource pooling and allocation, in handling competitive exposure to fluctuating exchange rates.

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1. Introduction

1.1. Problem motivation

As firms are globalizing their supply chains, they are facing increasing exposure to currency fluctuations. The risks associated with currency exposure can be significant. Currency fluctuations can often be of 20–40% within a year, with the 1997 Asian Crisis resulting in even higher devaluations overnight for some of the weaker currencies (e.g., Indonesian Rupiah). Such strong macro-economic shocks can lead to drastic deviations from expected profit performance and lead to heightened risk exposure. For example,

Honda Motor Co., the Japanese auto maker, with 80% of its profits generated in the U.S. market, was predicted to reduce its income by \$1.22 billion in 2004, because of the depreciations of dollar sales (Business Week 2004). German automakers suffered similar magnitude negative exposure effects in the face of the appreciating Euro of the last few years. In 2012, the global company executives had to make managing currency risks (particularly risks related to euro-denominated earnings) their top priority, due to the recent fiscal crisis in the eurozone peripheral countries.

Unfortunately, it has always been extremely hard to predict not only the magnitude but even the direction of change (positive or negative) of economic exposure to exchange rate shocks, as we have witnessed even earlier in the days of "Endaka" and "Super-Endaka" periods (of consistently appreciating Yen relative to the dollar of the 80s and early 90s), with the auto-industry again the example (Harvard Business School case 9-796-030: Japan's Automakers Face Endaka). An exchange rate regime heavily influenced by the US government actions to favor the domestic car makers ended up leading to erosion of their own market shares, competitive position and profitability.

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* Corresponding author. Tel.: +1 516 463 5730; fax: +1 516 463 4834.

E-mail addresses: dong@wustl.edu (L. Dong), kouvelis@wustl.edu (P. Kouvelis), Ping.Su@Hofstra.edu (P. Su).

¹ The authors contributed equally to this work.

Exchange rate shocks substantially affect the relative competitive position of firms as they are changing their cost structures, with the exact magnitude depending on their supply and demand network structures and the product lines of the competing firms. As a result, economic exposures to exchange rate shocks are hard to counteract.

Generally speaking, there are two types of exposure to currency exchange rate, transaction (contractual) and competitive (operating) exposure (see [Lessard and Lightstone, 1986](#) for a basic exposition of the concepts). Transaction exposure is caused by contracts denominated in a foreign currency. Competitive exposure explicitly captures the effects that currency fluctuations have on a company's future revenues and costs, as a result of the overall effect of such macro-economic changes on the competitive position of the firm. Transaction exposure is easy to identify and estimate its magnitude as it appears in financial statements and contractual agreements, and under reasonable assumptions on the distribution of the future exchange rates, it can be effectively handled through financial hedging approaches ([O'Brien, 1996](#)). Competitive exposure is heavily dependent on the global supply chain structure and product markets of the competing firms, and it is hard to estimate, as we argued above. Managing competitive exposure needs a longer-term perspective, and cannot be dealt with solely through the use of financial hedging techniques. It is well recognized, and mostly anecdotally advocated, in the finance and international business literature (see [Lessard and Lightstone, 1986](#) and [Hertzell and Caspar, 1988](#) among others, with a more comprehensive listing left for our literature review, [Section 1.2](#)) that operational hedging, such as operational flexibility of a global network of production facilities, can be an effective long-term way to handle it. However, a counter arguing literature has been built around risk avoidance and variance reduction strategies predicated on “natural hedges” (and their implications for structuring the network of global facilities of the firm) and financial hedging approaches for handling such exposures.

A frequently adopted operational approach by global firms is to create a “natural hedge” ([Pringle and Connolly, 1993](#); [Pringle, 1995](#); [Logue, 1995](#)), which is also called “matching the currency footprints” ([Harris et al., 1996](#)), by locating production facilities in the country where sales are generated. This way, costs and revenues are matched in the same currency and the firm's competitive exposure to currency fluctuation is eliminated. In an empirical study by [Bodnar and Marston \(2002\)](#), the authors document very low currency exchange exposure for a majority of firms in their sample that have used “natural hedges.” “Natural hedge” regains its popularity in the last few years. “Toyota Motor Corp., Renault SA (RNO) and Nissan Motor Co. are among carmakers widening their global production footprint to limit exposure to currency risk ([Business Week, March 2013](#)).” Meanwhile, US auto makers such as Ford and GM have increased their production in overseas markets despite their export-favoring weaker home currencies, but probably creating “natural hedges” in markets with increasing sales. However, the effectiveness of natural hedges is a point of heated debate (see [Harris et al., 1996](#)) to which our paper will add its unique, and reasonably conclusive from a profit maximizing objective, viewpoint. The main thrust of our argument is as follows.

The “matching the currency footprints” approach typically results in inflexible national or regional networks. As a result, it forgoes the operational flexibility of a global supply/production/distribution network in exchange for the false security of minimal risk of currency exposure of the firm's own (preplanned, and non-anticipation of competitive reactions) cash flows. Consequently, a firm that pursues this “natural hedge” approach is less capable in improving its profit and controlling its downside risk. We will formally advance this point with a stylized model of a global firm competing with a local firm in a foreign market in the presence of exchange rate uncertainties.

The main focus of our paper is on the effects of operational flexibility, such as allocation flexibility, on the performance of

firms facing global competition in the presence of currency uncertainties. “Allocation” flexibility (defined in [Ding et al., 2007](#)) refers to the ability to supply two markets from one flexible facility and make market commitment ex post. We consider a global firm selling to both domestic and foreign markets. In the foreign market, the global firm encounters competition from a local supplier. We consider two distinct operational settings: the global firm (a) employs the “natural hedge” approach and (b) introduces allocation flexibility. For these operational settings, we explore (1) What are the effects of allocation flexibility on the global firm's capacity strategy, and its deployment tactics, in response to the realized exchange rate shocks? and (2) How do allocation flexibility affect firms' profits and risks in response to fluctuating exchange rates?

Our results show that operational flexibility improves the global firm's expected profit and reduces its downside risk. Furthermore, the global firm's flexibility increases the local firm's downside risk, although it does not always decrease its expected profit. Moreover, we find that allocation flexibility mitigates the adverse effect of increasing competition in the foreign market on the global firm. These effects become more prominent as the volatility of exchange rate increases. Our analysis substantiates that allocation flexibility has robust performance in terms of both expected profit and downside risk in the presence of fluctuating exchange rates and foreign competition. Our results clearly disprove the effectiveness of “natural hedges” for dealing with competitive exposure for profit maximizing firms.

1.2. Literature review

Our work is related to the research of operational hedging in the operations management literature. In this literature, emphasis is given to modeling different types of operational hedging strategies, and the optimal operating (capacity, technology selection, inventory etc.) policy under operational flexibility in a single firm setting. [Boyabatli and Toktay \(2004\)](#) provide a survey of frequently used operational hedging strategies in operations management and identify two definitions of operational hedging in the literature: real options view and counterbalancing-action view. The real options view ([Huchzermeier and Cohen, 1996](#)) considers operational hedging strategies as real (compound) options that are exercised in response to demand, price and exchange rate contingencies. These real options have different forms: postponement of the allocation on foreign markets in [Ding et al. \(2007\)](#) and [Kazaz et al. \(2005\)](#), acquisitions in [Hankins \(2011\)](#), holding excess capacity in [Cohen and Huchzermeier \(1999\)](#), and switching options in [Kogut and Kulatilaka \(1994\)](#), [Cohen and Huchzermeier \(1999\)](#), [Dasu and Li \(1997\)](#), [Li and Kouvelis \(1999\)](#), and [Aytekin and Birge \(2004\)](#).

Specifically, the early influential work of [Huchzermeier and Cohen \(1996\)](#) values global manufacturing strategy options for a single firm (i.e., no competitive exposure considerations) under exchange rate risk. The operational hedge in their study is the use of excess capacity and production switching options. Their numerical study shows that operational hedging reduces the firm's downside risk. [Kogut and Kulatilaka \(1994\)](#) develop a stochastic dynamic programming model to investigate option value of the costly switching production between two manufacturing plants located in different countries under exchange rate uncertainty. [Aytekin and Birge \(2004\)](#) generalize this work and show that financial hedging is preferred for low volatility exchange rates and operational hedging is preferred for high volatilities. [Kouvelis et al. \(2001\)](#) study the effects of real exchange rates on the choice and dynamic adjustment of ownership strategies of production facilities of global firms supplying foreign demand. [Kazaz et al. \(2005\)](#) examine two complementary forms of operational hedging, production hedging where the firm deliberately produces under

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