



## Insider trading in a two-tier real market structure model<sup>☆</sup>

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### ABSTRACT

This paper investigates the real and financial effects of insider trading in the spirit of Jain and Mirman (2000). Unlike the existing literature, the production of one real good is costly and depends mainly on the price of an intermediate good produced locally by a privately owned firm. The results show that the output level of the final good chosen by the insider as well as the price of the intermediate good set by the privately owned firm are both higher than it would be in the absence of insider trading. Furthermore, the parameters of both real markets affect the stock price. Next, a second insider, operating in the firm producing the final good, is added to the benchmark model. Competition among insiders decreases the production of the final good by the publicly owned firm and the price of the intermediate good with respect to the benchmark model. Moreover, it affects the insiders' trades and increases the amount of information revealed in the stock price.

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## 1. Introduction

Corporate executives can hardly clear their minds of all bits of information they know when they trade on their company's stock market. Their daily participation in the real activities of their company, when writing for instance a sales report or discussing new product strategies in meetings, or even when chatting with someone in the research and development team, make them reluctantly form an opinion of how prospects look at the company. Because real and financial decisions are inevitably intertwined, the theoretical research on insider trading has started to extend the pure financial models in the spirit of Kyle (1985) to include the real aspects of the firm (Daher & Mirman, 2006, 2007; Jain & Mirman, 2000, 2002). The insider is modeled as the manager of the firm who chooses how much stock to buy and how much output to produce in the

real market, thus affecting the profitability of the firm. Sometimes, the publicly owned firm is a quantity-setting monopolist in the real market (Daher & Mirman, 2007; Jain & Mirman, 2000), and sometimes it is competing with another privately owned firm in a Cournot way to determine the quantity produced of the homogeneous good (Daher & Mirman, 2006; Jain & Mirman, 2002; Wang & Wang, 2010; Wang, Wang, & Ren, 2009). In both cases and to simplify the analysis, the real good is produced at no cost.

However, the production process involves the use of primary production factors such as labor, capital, and land, as well as intermediate goods. It is a characteristic feature of industrial economies that commodities are produced by means of commodities. Data from the OECD input–output tables (OECD, 2004) show that the share of intermediate goods in production ranges from 19% to 82% across different sectors. Any change in the cost of these intermediate goods will ripple throughout a market economy, affecting the market of the final good. In other words, buying and selling relationships link firms vertically, and through these links firms engage in market interactions while performing different functions in the value chain.

In this paper, we address this issue by assuming that the production of the final good by the publicly owned firm (the downstream firm) involves constant labor costs as well as costs of intermediate goods. Those are locally produced by a privately owned firm

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(the upstream firm).<sup>1</sup> Specifically, we analyze insider trading in a static model in the spirit of Jain and Mirman (2000), where the insider of the downstream firm is also the manager of that firm and thus makes both real and financial decisions. We study a model of insider trading and information dissemination when other firms are involved in the production process, e.g., producers of intermediate goods, thus affecting the real decisions of the model. In our model, the choice of the real variables will affect the market of the intermediate good, and vice versa. The logic is as follows: when the production of the final good decreases, the demand for the intermediate good also decreases, and *ceteris paribus*, the price of that good falls. Inversely, an increase (decrease) in the price of the intermediate good is able to decrease (increase) the profit of the downstream firm, *ceteris paribus*. A lower (higher) profit induces the market maker to set a lower (higher) stock price.

In our model, the downstream firm managed by the insider is assumed to be a monopolist. We follow Kyle (1985) in modeling the financial market environment and thus study a linear-normal equilibrium. Further, we assume that the stock orders are submitted by an insider as well as noise traders. A market maker sets stock prices competitively. The insider knows the true value of a random shock to the value of the firm whereas the market maker knows only the distribution of this shock. However, following Jain and Mirman (1999), the market maker observes the total stock order as well as the noisy market price of the real good before setting the price of the stock. The insider chooses the real output of the final good and the stock to be traded simultaneously. The downstream firm buys the necessary quantity of the intermediate good from the upstream firm, which also holds a monopoly power on the market of that good.

We show that insider trading affects the markets of both the final and the intermediate goods, and that the financial market variables change due to the insider's real decisions. For instance, the real output chosen by the insider or the manager of the downstream firm as well as the price of the intermediate good set by the upstream firm are both greater than it would be in the absence of insider trading. Furthermore, the parameters of both real markets affect the stock price and the stock pricing rule. Besides, when compared to Jain and Mirman (2000, 2002), this two-tier real market structure does not alter the amount of information disseminated in the stock price or the level of insider trading. However, it restricts the influence of the insider on the final good market and thus affects the real market outcomes as well as the stock price coefficients.

Next, following Daher and Mirman (2006, 2007), we add a second insider, the owner of the downstream firm, and assume that he has no managerial responsibilities. Similarly to the manager, the owner's objective is to maximize his profits from trading the stock of the firm. Then, we carry out a comparative static analysis between model II (duopoly in the financial market) and model I (monopoly in the financial market). We show that competition among insiders in the financial sector affects the stock price coefficients as well as the real variables. In particular, the level of output produced by the downstream firm and the price of the intermediate good both decrease with respect to model I. Hence, the addition of another informed trader influences the production decision of the downstream firm, as well as the decision of the upstream firm. Moreover,

<sup>1</sup> It is realistic to assume that the downstream is publicly owned while the upstream firm is privately owned. An example supporting this assumption is to imagine a ready-mixed concrete producer, publicly owned and procuring cement from a small-size upstream firm. Another example consists in producers of automobile batteries that procure battery separators from an upstream firm.

competition among insiders affects the insiders' trades. Finally, the results show that Cournot competition in the stock market increases the amount of information revealed through the stock price.

The paper is structured as follows. Section 2 presents and discusses the main findings of the benchmark model characterized by a two-tier real market structure and one insider in the financial market. Section 3 adds a second insider in the financial market and carries out a comparative static analysis with respect to the benchmark model.

## 2. Model I: the monopoly case

Let  $(\Omega, \mathcal{F}, \mathbb{P})$  be a probability space, all the random variables are defined with respect to this probability space. Consider an economy characterized by a financial sector and a two-tier real market structure in which the production of a final good requires an intermediate good (or service). More specifically, the real market is characterized by two firms, the downstream firm holding a monopoly in producing the final good and the upstream firm also holding a monopoly in the production of the intermediate good.<sup>2</sup>

The structure of the real market draws on existing models that explore the effect of foreign direct investment on backward linkages.<sup>3</sup> More specifically, our model is a variant of the Cournot model developed in Lin and Saggi (2007), which in turn is based on Salinger (1988). For producing one unit of the final good, the downstream firm requires  $l$  units of labor and  $c$  units of the intermediate good. The marginal cost of producing one unit of the final good is then equal to the sum of the labor cost and the cost of intermediate goods. For simplicity, the wage rate is normalized to one. The price of the intermediate good  $w$  is set by the upstream firm. The inverse demand function for the final good is assumed to be linear and stochastic, i.e.,

$$q' = (a - y)\bar{z} \quad (1)$$

and the unitary profit of the downstream firm is also stochastic and given by,<sup>4</sup>

$$\varpi' = (a - y - l - cw)\bar{z} \quad (2)$$

where  $a$  is positive constant and  $\bar{z}$  is a random variable, normally distributed with mean  $\bar{z}$  (assumed positive) and variance  $\sigma_z^2$ .

The upstream firm produces the intermediate good at a constant marginal cost  $\tau$ . The downstream and upstream firms interact in a two-stage process. First, the upstream firm chooses simultaneously the quantity of the intermediate good to supply, and its unitary price  $w$ . Second, the manager of the downstream firm decides the amount of the final good  $y$  to produce given the price of the intermediate good  $w$ .

On the other hand, we consider a financial market where the upstream firm is privately owned and the downstream firm is publicly owned. The stock of the downstream firm is publicly traded

<sup>2</sup> Note that the monopoly structure adopted in the real market can be easily extended to Cournot oligopoly in the market of both the final and the intermediate goods.

<sup>3</sup> See for example Batra, Morisset, and Saggi (2003) and Lin and Saggi (2007).

<sup>4</sup> Note that the unit cost depends on  $\bar{z}$ . This assumption is undoubtedly realistic. For instance, in a publicly owned company operating in the mining sector, corporate executives can hardly clear their mind of all they know about successful research that is undertaken in the research and development department. Such developments, aiming for example at reducing production costs, enhancing the quality of existing mineral commodities and reducing adverse environmental, health, and safety impacts, are expected to affect both the price and the cost of the company's product. The insiders can then benefit from this non-public information to trade on the company's stock market.

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