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The incentive to trade under ambiguity aversion

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ABSTRACT

This paper examines the behavior of an exporting firm that sells in both the home country and a foreign country. The firm makes its optimal production and export decisions when facing ambiguous exchange rate risk. Ambiguity is modeled by a second-order probability distribution that captures the firm's uncertainty about which of the subjective beliefs govern the exchange rate risk. Ambiguity preferences are modeled by the (second-order) expectation of a concave transformation of the (first-order) expected utility of profit conditional on each plausible subjective distribution of the exchange rate risk. Within this framework, we derive necessary and sufficient conditions under which the ambiguity-averse firm optimally sells more in the home country and exports less to the foreign country in response either to the introduction of ambiguity or to greater ambiguity aversion when ambiguity prevails. We further show that ambiguity and ambiguity aversion have adverse effect on the firm's incentive to export to the foreign country.

1. Introduction

The study of an exporting firm under exchange rate uncertainty has been the subject of considerable research in decision making under uncertainty (Broll and Zilcha, 1992; Katz and Paroush, 1979; Kawai and Zilcha, 1986; Viaene and Zilcha, 1998; Wong, 2007; to name just a few). The extant literature examines the production and export decisions of the exporting firm using the standard von Neumann–Morgenstern expected utility representation. Such a modeling approach rules out the possibility that the firm is unable to unambiguously assign a probability distribution that uniquely describes the exchange rate risk, which gives rise to ambiguity, or uncertainty in the sense of Knight (1921).

Since the seminal work of Ellsberg (1961), ambiguity has been alluded to the violation of the independence axiom, which is responsible for the decision criterion being linear in the outcome probabilities. There are ample experiments (Chow and Sarin, 2001; Einhorn and Hogarth, 1986; Sarin and Weber, 1993) and surveys (Chesson and Viscusi, 2003; Viscusi and Chesson, 1999) that document convincing evidence that individuals prefer gambles with known rather than unknown probabilities, implying that ambiguity aversion prevails.

The purpose of this paper is to incorporate ambiguity into the model of an exporting firm that sells in both the home country and a foreign country. Klibanoff et al. (2005) have recently developed a powerful decision criterion known as "smooth ambiguity aversion" that is compatible with ambiguity averse preferences under uncertainty (hereafter referred to as the KMM model). The KMM model features the recursive structure that is far more tractable in comparison to other

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models of ambiguity such as the pioneering maxmin expected utility (or multiple-prior) model of Gilboa and Schmeidler (1989). Specifically, the KMM model represents ambiguity by a second-order probability distribution that captures the firm's uncertainty about which of the subjective beliefs govern the exchange rate risk. The KMM model then measures the firm's expected utility under ambiguity by taking the (second-order) expectation of a concave transformation of the (first-order) expected utility of profit conditional on each plausible subjective distribution of the exchange rate risk. This recursive structure creates a crisp separation between ambiguity and ambiguity aversion, i.e., between beliefs and tastes, which allows us to study these two attributes independently. Another nice feature of the KMM model is that we can apply the conventional techniques in the decision making under uncertainty in the context of ambiguity (Alary et al., 2013; Gollier, 2011; Snow, 2010, 2011; Taboga, 2005; Wong 2015a, b).

Within the KMM model, we derive necessary and sufficient conditions under which the ambiguity-averse exporting firm optimally sells more in the home country and exports less to the foreign country in response either to the introduction of ambiguity or to greater ambiguity aversion when ambiguity prevails. We show that these conditions hold when the firm's coefficient of relative risk aversion does not exceed unity and its subjective beliefs are ranked in the sense of first-order stochastic dominance. Barham et al. (2014) document that the average coefficient of relative risk aversion is 0.8 in their sample of Midwestern grain farmers in the U.S., which is in line with the magnitudes of relative risk aversion found in many developing countries (Cardenas and Carpenter, 2008). Since exporting to the foreign country exposes the firm to the exchange rate risk, the prevalence of ambiguity creates additional risk to the ambiguity-averse firm. Hence, the firm finds it less attractive to export to the foreign country in the presence than in the absence of ambiguity. This result extends to the case of greater ambiguity aversion. Ambiguity and ambiguity aversion as such have adverse effect on the firm's incentive to export to the foreign country.

The rest of this paper is organized as follows. Section 2 delineates the KMM model of an exporting firm that sells in both the home country and a foreign country. The firm faces ambiguous exchange rate uncertainty in the sense of Knight (1921). Section 3 derives the firm's optimal production and export decisions. Section 4 examines how ambiguity and ambiguity aversion affect the value of export to the foreign country. The final section concludes.

2. The model

Consider an exporting firm that faces exchange rate uncertainty. There is one period with two dates, 0 and 1. To begin, the firm produces a single homogeneous good in the home country according to a known cost function, $C(Q)$, where $Q \geq 0$ is the level of output and $C(Q)$ is compounded to date 1. The firm's production technology exhibits decreasing returns to scale so that $C(0) = C'(0) = 0$, and $C'(Q) > 0$ and $C''(Q) > 0$ for all $Q > 0$.

At date 1, the firm sells its entire output, Q, in the home country and a foreign country. The firm commits its allocation of output at date 0 such that Q_d units of the good are sold in the home market and the remaining units, $Q_f = Q - Q_d$, are exported to the foreign market, where $0 \leq Q_d \leq Q$. The firm is a price taker in both the home and foreign markets. The selling price in the home market is P_d per unit, where $P_d > 0$ is denominated in the home currency. On the other hand, the selling price in the foreign market is P_f per unit, where $P_f > 0$ is denominated in the foreign currency.[1] The firm's profit at date 1, denominated in the home currency, is given by

$$\tilde{\Pi} = P_d Q_d + \tilde{S} P_f Q_f - C(Q_d + Q_f), \tag{1}$$

where $\tilde{S}$ is the random spot exchange rate at date 1 and is expressed in units of the home currency per unit of the foreign currency.[2] The firm possesses a von Neumann–Morgenstern utility function, $U(\Pi)$, defined over its home currency profit at date 1, Π, with $U'(\Pi) > 0$ and $U''(\Pi) < 0$, indicating the presence of risk aversion.

The spot exchange rate, $\tilde{S}$, is distributed according to an objective cumulative distribution function (CDF), $F^o(S)$, over support $[\underline{S}, \overline{S}]$, where $0 \leq \underline{S} < \overline{S} \leq \infty$. The firm faces ambiguity in that it is uncertain about the objective CDF, $F^o(S)$. Succinctly, the firm has a continuum of priors, $\{F(S|\theta)\colon \theta \in [\underline{\theta}, \overline{\theta}]\}$, where $F(S|\theta)$ denotes a plausible first-order CDF of $\tilde{S}$ over support $[\underline{S}, \overline{S}]$, which is sensitive to a parameter, θ, whose value is not known ex ante. Based on its subjective information, the firm associates a second-order CDF, $G(\theta)$, over the continuum of priors, i.e., over support $[\underline{\theta}, \overline{\theta}]$, where $-\infty \leq \underline{\theta} < \overline{\theta} \leq \infty$. This captures the firm's uncertainty about which of the first-order CDF, $F(S|\theta)$, governs the random spot exchange rate, $\tilde{S}$. Following Gollier (2011), Snow (2010, 2011), and Wong (2015a,b), we assume that the firm's ambiguous beliefs are unbiased in the sense that the expected exchange rate risk is equal to the objective exchange rate risk:

$$\mathrm{E}_G[F(S|\tilde{\theta})] = F^o(S), \tag{2}$$

for all $S \in [\underline{S}, \overline{S}]$, where $\mathrm{E}_G(\cdot)$ is the expectation operator with respect to the second-order CDF, $G(\theta)$.[3]

[1] Due to the segmentation of the home and foreign markets, arbitrage transactions are either impossible or unprofitable, thereby invalidating the law of one price. See Roberts and Tybout (1997), Engel and Rogers (1996, 2001) and Parsley and Wei (1996) for supportive evidence that arbitrage transactions among national markets are indeed imperfect.

[2] Throughout the paper, random variables have a tilde (~) while their realizations do not.

[3] The assumption that the expected exchange rate risk is equal to the objective exchange rate risk is motivated by the premise that the behavior of an