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Infant industry protection and industrial dynamics

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ABSTRACT

A perennial case for industrial policy is based on the protection of young or emerging industries. Despite a natural association with concepts of life cycles, industrial policy has not been analyzed in the context of an industry life-cycle model. In particular, an important life-cycle characteristic, the potential for very large changes in the rate of net entry, is ignored. In this paper, we demonstrate how the impact of industrial policy depends critically on the entry and exit dynamics within an industry. We construct a model of technology adoption in which the number of firms is endogenous, and derive a set of novel predictions about the effects of protection on firm technology decisions. Specifically, we show that permanent protection can induce earlier adoption, but also decreases the probability that a given firm adopts the new technology. Likewise, we demonstrate that reducing the duration of protection results in faster adoption than permanent protection, but also reduces a given firm's probability of adoption. Finally, we show that, for industries characterized by flexibility in firm numbers, protection does not change the rate of technology adoption but does increase the size and probability of a shakeout (large scale net exit).

1. Introduction

A primary justification for protecting infant industries from foreign competition is to allow them to close the gap with more technologically advanced foreign competitors.[1] For example, the justification given by the U.S. government in 1983 for its decision to raise safeguard tariffs on foreign motorcycles was to help Harley-Davidson "introduce innovative new manufacturing and management technologies, many of which were learned from its Japanese competitors".[2] Given the pervasiveness of this argument, it is not surprising that there is an extensive literature analyzing the impact of protection on a firm's decision to innovate and adopt new technologies (e.g., see (Matsuyama, 1990; Rodrik, 1992; Miyagiwa and Ohno, 1995; Miyagiwa and Ohno, 1999; Crowley, 2006). These studies have typically analyzed protection in the context of models where the number of firms is fixed (usually two firms, home and foreign, engaged in Cournot competition). However, this focus on a single domestic firm neglects a number of important issues related to the major objective of protection: the transition from an infant industry to a mature industry. These single-firm models cannot address questions concerning the diffusion of technology through an industry (i.e., how trade policy influences both the speed and likelihood of technology adoption across firms). Nor can they discuss whether trade barriers have similar effects on productivity in industries exhibiting different evolutionary patterns (i.e., different rates of net entry over time). These issues are fundamental to understanding the implications of protection, especially when it is aimed at helping infant industries close technology gaps.

The starting point of our paper is a model that endogenizes both the state of technology and the number of firms in an industry (and thus endogenizes the evolution of the industry over time). The decision to endogenize industry evolution is perhaps not surprising given the centrality of endogenous entry and exit decisions in the recent influential work on firm heterogeneity and productivity by Melitz (2003) and Bernard et al. (2003). However, these papers explicitly assume the exogeneity of both firm productivity and firm heterogeneity, as they focus on the implications of trade on industry productivity. In contrast, the trade and technology diffusion literature mentioned above explicitly assumes that firm heterogeneity and productivity are endogenous. The main contribution of this paper is to demonstrate how endogenous entry and exit dynamics are also important in understanding the productivity implications of trade policy in models of endogenous technological diffusion. In the sense of combining endogenous firm heterogeneity with endogenous firm entry, our paper is most similar to Ederington and McCalman (2007, 2008), which also analyze the productivity implications of trade protection. However, these papers both assume that industries are characterized by a constant number of infinitely lived firms, all of whom eventually adopt the productivity-improving technology. Thus,

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[1] For a recent survey of the issues see Saggi and Pack (2006).

[2] For an overview of the Harley-Davidson case, see Crowley (2006). See Bown and Crowley (2005) for an overview of safeguards.

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endogenous entry and exit dynamics play only a minor role in both papers.[3] This paper relaxes these assumptions and shows that the endogeneity of entry and exit is critical for the analysis, since the number of firms in the market is a key variable in the determination of the impact of trade policy on innovation and adoption decisions. Specifically, this paper makes three main contributions to our understanding of the productivity implications of infant industry protection.

First, it is standard in the technology adoption literature to assume that the cost of adopting a new technology declines to the point where eventually all firms in the market adopt the new technology. In contrast, we consider the case where adoption costs are bounded such that, even in the limit, some firms might optimally decide to forgo adopting a new technology. This case is important to consider because, as we show, protection has very different implications for the timing of adoption and the probability of adoption (i.e., the probability that a given firm will eventually adopt the new technology). Specifically, while protection might increase the speed at which some firms adopt new technologies, it can also decrease the probability that a given firm chooses to adopt. The reason for this difference is subtle but intuitive. Note that, with endogenous firm entry, while protection may reduce the degree of foreign competition (by placing foreign competitors at a cost disadvantage), it also increases the degree of domestic competition by encouraging new entrants into the market. Thus, protection is modeled as shifting the intensity of competition away from foreign competitors, not simply as an exogenous decrease in the degree of competition. In an industry that is initially subject to a technology gap relative to foreign competitors, such increased domestic competition has little impact early in the life of the industry (when all domestic firms are low-tech). Thus, the decline in foreign competition increases the market share of domestic firms, causing a substantial number of firms to speed up technology adoption (since increased market share implies increased benefits to adopting cost-saving innovations). Intuitively, the timing of adoption is a function of current conditions, and protection can result in a temporary increase in firm size and thus increased rates of adoption. However, the decision of whether or not to adopt in the long run involves the comparison of the future profit stream from adoption with the costs of adoption. As we show, this increase in domestic competition (i.e., the entry of new firms) decreases that future (post-adoption) profit stream and thus reduces the proportion of firms that eventually adopt.

Second, we explicitly consider the implications of temporary protection, because the escape clauses in Article XIX of the General Agreement on Tariffs and Trade (GATT) that legitimize infant industry protection require any such protection to be temporary. As we show in this paper, imposing a termination date for protection has important implications for the impact of tariffs on technology adoption. Specifically, it implies an increased *rate* of adoption (as compared to permanent protection), but also a decreased *probability* of adoption. While these results may seem contradictory, the intuition is clear: removing protection at some exogenous point in the future means that the future profit stream of a domestic firm will be reduced. This decreased profit stream deters entry by domestic competitors, thus increasing the market share and rate of adoption by domestic firms at the time of protection. However, the lower future market share decreases the incentive to adopt new innovations, reducing the probability that a given firm chooses to adopt.

Finally, we extend the analysis to consider the impact of protection for industries that reach maturity through different life-cycle experiences. In particular, we consider two life-cycle scenarios: (1) stable industries where the costs of entry are relatively high and the number of firms is constant over time; and (2) flexible industries where the costs of entry are relatively low, resulting in episodes of both high initial net entry and a subsequent period of high net exit (i.e. a shakeout). We show that while a tariff may affect technology diffusion in stable industries, it will have no impact on technology adoption in industries characterized by flexibility in firm numbers over time. Intuitively, this is due to the fact that, with free entry and exit, it is the number of firms in the industry that adjusts to the change in tariff levels (negating any impact on an individual firm's decisions). Indeed, we show that, in such "flexible" industries, protection can be counter-productive, as it will serve only to increase the size of the shakeout without having any appreciable effect on technology adoption. Furthermore, protection can cause an industry to change its life-cycle characteristics, switching from a relatively stable market structure to one which experiences a dramatic shakeout.

Section 2 of the paper provides our model of a firm's decision to adopt productivity-enhancing technology under monopolistic competition. In Section 3 we consider the impact of permanent protection on the rate of adoption and the probability of adoption. Section 4 is concerned with the case of temporary protection. In Section 5 we consider the different life-cycle profiles of industries and how they are affected by protection. Finally, in Section 6 we conclude.

2. Model

Describing industries as "infant" draws a natural analogy to the notion of a life cycle. Therefore, it is somewhat surprising that the analysis of infant industries has not been conducted in the context of a model of an industry life cycle. In this section we develop an industry life-cycle model where technological change is driven by firms' decisions to adopt new technology. The adoption decision of firms follows the standard setup as presented in Reinganum (1981). This basic framework is integrated into a model of monopolistic competition.[4] While our framework is similar to Reinganum (1981) in that firms can be interpreted as pre-committing to an adoption date at time zero, it does not share an important feature of her equilibrium, that an earlier adopter does better than a later one. It was on this basis that Fudenberg and Tirole (1985) developed their model of rent equalization and preemption. In their duopoly framework, firms do not pre-commit to an adoption date but rather can alter their decision in real time in response to the actions of their rival. Under this assumption profits must be equalized in equilibrium. Assuming that firms are engaged in monopolistic competition achieves both diffusion as an equilibrium outcome and the rent equalization result of Fudenberg and Tirole (1985). Moreover, this framework has the advantage that the number of firms is endogenous, an outcome that is not feasible in the Fudenberg and Tirole model.

2.1. Preferences and consumption decisions

We assume that the economy has two sectors: one sector consists of a numeraire good, x_0, while the other sector is characterized by

[3] Ederington and McCalman (2008) investigates the effects of trade policy on symmetric countries while Ederington and McCalman (2007) considers asymmetric countries. However, the analysis in both papers is conducted under three specific conditions: universal adoption, permanent protection and a constant number of firms (i.e., fixed costs of production sufficiently low so that the number of firms doesn't change over the industry lifetime). In this paper, we relax all three of these assumptions and demonstrate the importance of modeling entry/exit dynamics in understanding the productivity implications of trade barriers.

[4] By considering adoption in a setting of monopolistic competition we are following Götz (1999) and Ederington and McCalman (2008). However, both of these papers use constant elasticity of substitution preferences. In contrast, we employ a quadratic utility function, which allows the degree of competition to affect the markups set by firms. Moreover, Ederington and McCalman (2008) consider symmetric countries and the decision to export. They do not address life-cycle issues associated with market structure or infant industry protection. For models that emphasize trade and technology in a strategic setting, see Bagwell and Staiger (1992); Miyagiwa and Ohno (1995) and Crowley (2006).