Reputation, Learning, and International Trade∗

John T. Dalton and Turkmen Goksel†
University of Minnesota
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Abstract

Asymmetric information impacts the decisions of importers and exporters engaged in international trade; as such, learning and reputation building are some of the key determinants of the dynamics of international trade patterns. This paper incorporates learning and reputation building into a simple dynamic stochastic model of international trade with asymmetric information. We use the model to study two bilateral trade flows influenced significantly by learning and reputation, namely United States imports of Japanese and French cars over the period 1961-2005. Numerical simulations of the model are capable of replicating these events in a robust fashion. In addition to matching these events, we explore further implications of our framework for understanding international trade patterns. Since learning and reputation building require time, predicted short run trade patterns can be quite different than those predicted in the long run. Sectorial differences in the speed of learning and reputation building affect predicted trade patterns. The extent of asymmetric information existing between importers and exporters also changes under different trade policies.

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†Contact: Department of Economics, University of Minnesota, 4-101 Hanson Hall, 1925 Fourth Street South, Minneapolis, MN, 55455. Email: jtdalton@umn.edu and turkmen.goksel@politics.ankara.edu.tr.
1 Introduction

This paper studies how asymmetric information affects international trade patterns and how learning and building up a reputation may be crucial in reducing information problems in international trade. In the framework we develop, asymmetric information exists regarding producers’ (exporters’) characteristics. Consumers (importers) cannot completely observe the characteristics of exporters and have imperfect information about them, whereas exporters fully know their own characteristics. These informational asymmetries create frictions in the business dealings between importers and exporters which inhibit the flow of goods internationally. Since learning (for importers) and reputation building (for exporters) requires time, we find predicted short run trade patterns can be quite different than those predicted in the long run. Our framework provides new tools for analyzing data on international trade flows. We apply these tools to the case of Japanese and French car exports to the United States, finding that numerical simulations of our model are capable of replicating these trade flows in a robust fashion.

Since the publication of Akerlof (1970), it has been well understood how asymmetric information can cause adverse selection in markets. We argue that asymmetric information problems are also crucial in international markets, even more so than closed economies, since information regarding foreign exporters is potentially less available and more difficult to access. For instance, inspection of foreign exporters may be difficult and costly to undertake. As a result, asymmetric information problems about a foreign exporter’s productivity or the quality of a foreign exporter’s good can be more severe in international markets. Additional factors, such as culture, language, or religion, have further effects on international markets with informational asymmetries. These factors can either exacerbate the problem by building prejudices between groups who differ in these respects or alleviate it by networking geographically dispersed groups together who are similar in these respects.

1In general, the characteristics we discuss here can be thought of as affecting the consumers’ beliefs, such as producers’ productivity, quality, reliability, etc. For simplicity, we later narrow our concept of characteristics to be just productivity in our model.

2See, for example, Guiso, Sapienza, and Zingales (2009) for a study involving a set of European Union countries on how culture effects trust between citizens of different countries and how these bilateral trust relations affect international trade, portfolio investment, and foreign direct investment. See Gould (1994), Greif (1989), and Rauch and Trindade (2002) for examples of ethnic-based networks as means to alleviate asymmetric information problems and facilitate international trade.
In environments with informational asymmetries, Spence (1973) demonstrates how signaling can improve the market outcome, and Shapiro (1983) shows how building up a reputation can be important as well. Similarly, in international markets, exporters can use signals to build their reputations and alleviate problems caused by asymmetric information. Falvey (1989) extends the framework used in Shapiro (1983) to study the effects of commercial trade policies, such as origin labelling requirements, in a world in which reputation matters.

In parallel to the above findings, we argue that all these concepts—asymmetric information, learning, signaling, and reputation building—are important in international trade and should be incorporated into models in the international trade literature. The international trade literature usually implicitly assumes perfect information among agents, and, hence, asymmetric information plays no role.\(^3\) Since the main goal of this paper is to emphasize the idea that reputation building and learning are important in determining trade patterns, we focus our attention on developing a simple mechanism which clearly shows the relation between these forces. Our model is not based on traditional trade theory models and excludes some features of standard models. In particular, we take trade incentives as given and then narrow our attention to how asymmetric information, reputation, and learning affect international trade. Future research can incorporate these ideas into existing trade models. We then apply our mechanism to the study of Japanese and French car exports to the United States. The results of our analysis suggest researchers should consider information dynamics when trying to understand international trade data.

The mechanism we propose works as follows: There are two types of agents, exporters and importers. Exporters have private information about their characteristics. Importers only have beliefs about these characteristics. Importers wish to exchange their endowments for the output produced by exporters. The importers make offers to exporters in exchange for shipments of exporters’ goods. These offers are based on beliefs importers hold about exporters’ characteristics. Importers’ beliefs, in turn, depend on the export history of an exporter, that is, an exporter’s reputation. Exporters choose to accept or reject the offer depending on its profitability and how acceptance may affect the exporters’ reputations. Hence, exporters potentially have the

\(^3\)See, however, Nieuwerburgh and Veldkamp (2009) for a recent treatment of asymmetric information and learning in the international finance literature.
chance to send signals to affect the beliefs of importers through their acceptance of an offer and their output performance. An exporter can either build up a good or bad history or reputation through their output performance. Importers learn about the characteristics of exporters after receiving and consuming the shipment of goods and update their beliefs accordingly. All importers share common information. Updated beliefs affect future decisions, because importers change their offers according to their updated beliefs. After learning about the exporters, if an importer undervalued (overvalued) their characteristics and shipments of goods previously, then the importer can raise (lower) the offers.

We use our model to study the contrasting experiences of United States car imports from Japan and France over the years 1961-2005. The evolution of these two trading experiences depends in part on asymmetric information, learning, and reputation. Very few Japanese and French cars were exported to the United States before the 1970’s. Before that time, big American cars ruled the road. American consumers showed little interest in the lightweight compact cars slowly trickling into the American market from Asia and Europe. The oil crises of the 1970’s changed all that, though, as Americans began to show an interest in the fuel efficient Japanese and French cars.

As American consumers learned more about the new Japanese cars, they discovered that not only were the Asian imports fuel efficient, but they were well-built and reliable vis-à-vis their American rivals. Japanese cars established a good reputation, as evidenced by such publications as Consumer Reports. Japanese car imports to the United States increased dramatically thereafter. In addition, Wojcik (2001) documents total sales of Japanese cars in the United States as increasing by 427% over the years 1971-1990, while total new car sales increased by only 9%. Total sales numbers for Japanese cars from 1971 to 1990 are primarily being driven by imports, since Japanese manufactures did not begin setting up factories in the United States until the mid-1980’s.

The experience of French cars differed greatly from the Japanese. Imports of the diesel-powered French cars initially increased sharply around the second oil crisis in 1979. However, as American consumers learned more about the new French cars, they discovered frequent mechanical failures and the need for constant repairs. French cars were unreliable and gained a bad reputation, which, again, can be seen in publications such as Consumer Reports. Despite
the initial attraction for being diesel-powered, United States imports of French cars eventually almost stopped. To this day, French cars are not exported to the United States at any sizeable level.

In order to apply our model to the experiences of United States imports of Japanese and French cars, we simulate our model numerically to generate sample model time series data. The model’s parameters are chosen using two alternative procedures, one of which is a maximum likelihood method. We compare the simulated model data with the actual time series data and find that the model does a good job of matching the actual data. We show the reliability of these results with a test of robustness. Our test consists of simulating the model 10000 times and calculating the average model time series. We then construct a confidence interval around this average by adding and subtracting two standard deviations measured from the 10000 simulations of model data. These bands convey the robustness of our results. After showing the capability of our model in capturing the Japanese and French car experiences, we discuss further results from our model which highlight the effects of asymmetric information, learning, and reputation in international trade.

Even though the structure of our model differs from Melitz (2003), it predicts similar results, namely that firms engaged in exporting are relatively more productive. However, this is a long run result, which corresponds to the case when asymmetric information problems have been reduced. In our model, the reduction of asymmetric information problems occurs when importers’ beliefs are similar to the actual characteristics of the firms. In this case, our model makes the same predictions as Melitz (2003). In the short run, however, when asymmetric information still exists between importers and exporters, the results of our model are different. A firm’s ability to export depends not only on its characteristics but also on what importers believe about those characteristics. Hence, an important implication of models with asymmetric information is that short run trade patterns can be quite different from those seen in the long run. Consequently, this can affect things like government policies as well.

One could argue that the learning and reputation building process generating the transition from the short (high informational asymmetries) to long run (low informational asymmetries) trade patterns occurs quite quickly. This might be true for some sectors, such as foods and beverages, in which it is easier to obtain information and update beliefs. For other sectors,
however, the speed of the learning and reputation building process is much slower. Shapiro (1983) cites the automobile industry as such a sector. Information regarding a particular car or car manufacture is revealed slowly over the course of the entire life of that car. Characteristics such as reliability can only be observed after long periods of time. Our model captures this sectorial difference in the speed of learning and reputation building with a parameter. We then show how our model’s predicted trade patterns change with changes in this parameter.

We measure the extent of asymmetric information existing between importers and exporters in our model by identifying the relation between importers’ beliefs and exporters’ true characteristics. Tracking this relation over time allows us to show how the informational environment in which importers and exporters interact changes. The relation between importers’ beliefs and exporters’ true characteristics can be thought of as a policy variable, which can be affected through different channels. We show that the incorporation of trade barriers or export subsidies in our model affects this relation, alongside the effects on trade patterns. In the case of trade barriers, exporters find it more difficult to export, which draws out the learning and reputation building process. As a result, the length of time required to reduce asymmetric information increases compared to the free trade case with no export subsidy policy. Export subsidies produce the opposite result. The learning and reputation process shortens, as exporters now find it easier to export with the aid of subsidies. It then follows that asymmetric information between importers and exporters decreases faster than the free trade case with no export subsidy policy.

The remainder of the paper is organized as follows: Section 2 describes the model in detail. In section 3, we use our model to evaluate the experience of United States car imports from Japan and France. In section 4, we discuss additional model results. Section 5 concludes.

2 Model

In this section, we develop a dynamic stochastic model of international trade with asymmetric information. This model is not built upon a standard international trade model and excludes some features of these models, as mentioned in the introduction. Instead, our model focuses exclusively on how asymmetric information, reputation, and learning can be crucial in the international trade literature.
As discussed in the introduction, exporters build their reputations based on characteristics observed by importers. For example, we could model reputation based on expected quality or, as we prefer to do here, expected productivity. In the case of expected quality, we could fix the output produced by each exporter \( i \), normalizing it to 1 for simplicity, and allow for different quality levels. Given the representative importer enjoys consuming different levels of quality simultaneously, importers make offers to each exporter \( i \) according to their expectations for quality conditional on their information set. In this case, exporters choose the quality level to export in order to affect the importers’ beliefs.

What we do in this model is an isomorphic version of the above. Instead of fixing the output level, we focus on a homogeneous good, normalizing the price to 1. We then allow different levels of output for each exporter \( i \). The importers’ offers are determined by expected quantity. Exporters now choose their output level to affect the importers’ beliefs instead of quality. Hence, our model captures the idea of reputation as being the ability to produce more of the same good per period. We do this for simplicity. In general, our idea of reputation captures not only productivity, but also characteristics like quality, reliability, etc.

### 2.1 Environment

Consider an economy with two countries, home and foreign. The home country contains a continuum of identical risk-neutral importers, and the foreign country contains a finite number of risk-neutral exporters which operate independently of one another. We are mainly interested in studying imports to the home country, which is why we divide our economy’s agents into home country importers and foreign country exporters.

Foreign country exporters produce and potentially export a homogeneous good, \( y \), to the home country. In contrast, importers do not possess the technology to produce \( y \). In each period, importers are endowed with \( \omega \). Importers want to exchange their endowment, \( \omega \), for good \( y \). Since we are focusing on studying imports to the home country, domestic production is not modeled. In the case of the home country, this can be interpreted as there also being domestic production for goods similar to \( y \), but not exactly the good \( y \). Due to taste for variety,

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4 This two country model can easily be extended to the multi-country case.
5 Adding domestic production to our model will not change the qualitative nature of the results.
the home country also wants to consume good y. In the case of the foreign country, this can be interpreted as all the exporters producing for their domestic market with some getting the chance to export and some not. Lastly, the economy exists for an infinite number of discrete time periods indexed by \( t = 0, 1, \ldots \).

### 2.2 Information Structure and Uncertainty

The key feature of this model is asymmetric information between importers and exporters. Exporters, indexed by \( i = 1, 2, \ldots, I \), have potentially different actual productivity levels, \( \eta_i \). Productivity levels are assumed to be fixed over time, that is, at the beginning of time \( t = 0 \), each exporter is assigned a productivity level, which they keep forever. These actual productivity levels are exporters’ private information and are incompletely known by importers. Rather, importers hold prior beliefs, \( \hat{\eta}_i^0 \), about each exporter’s actual productivity level, \( \eta_i \). Importers’ prior beliefs, \( \hat{\eta}_i^0 \), are assumed to be normally distributed with mean \( \mu_{\hat{\eta}_i^0} \) and variance \( \sigma^2_{\hat{\eta}_i^0} \). As time passes, learning about \( \eta_i \) will occur through the observation of exporter \( i \)’s output. This gives rise to endogenously determined posterior beliefs, which will affect the status of the exporters.

Importers cannot directly observe the productivity level of individual exporters due to idiosyncratic productivity shocks, \( \epsilon_{it} \). We assume that \( \epsilon_{it} \) is normally distributed with mean zero and variance \( \sigma^2_\epsilon \). We also assume productivity shocks are i.i.d. across exporters and time. These productivity shocks, \( \epsilon_{it} \), along with an exporter’s productivity level, \( \eta_i \), determine exporter \( i \)’s output, \( y_{it} \), at time \( t \), which is given by the technology\(^6\)

\[
y_{it} = \max\{\eta_i + \epsilon_{it}, 0\},
\]

where each exporter \( i \) knows the actual realization of \( \epsilon_{it} \) at the beginning of each period \( t \), but importers only know the distribution of \( \epsilon_{it} \). The exporters’ production technology is assumed to be publicly known. Under the above specification of the productivity shocks’ distribution, we refer to \( \epsilon_{it} < 0 \) as “bad” shocks and \( \epsilon_{it} > 0 \) as “good” shocks, since they decrease or increase an exporter’s output respectively.

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\(^6\)We do not allow the case when \( y_{it} < 0 \). This restriction implies a negative productivity shock can at most reduce an exporter’s output to zero.
Recall that $\eta_i$ is fixed over time for each exporter and is private information from time $t = 0$ onwards. In contrast to exporters, importers cannot observe $\eta_i$ and $\epsilon_{it}$ separately but can only observe the total output, $y_{it}$, if the exporter ships goods to the home country. Importers update their beliefs according to the total output they observe being shipped by each exporter. Information about each exporter perfectly spreads among the importers. In the event that an exporter chooses not to ship any amount of the good, $y_{it}$, in a given period, then importers do not change their beliefs about this exporter.

Exporters also experience idiosyncratic cost shocks, $u_{it}$. We assume that $u_{it}$ is normally distributed with mean zero and variance $\sigma_u^2$. The cost shocks are i.i.d. across exporters and time. Both exporters and importers know the distribution of $u_{it}$, but only exporters observe the actual realization of $u_{it}$. The exporters’ cost function is assumed to be publicly known:

$$c_{it} = \max\{f - u_{it}, 0\},$$

(2)

where $f$ is a fixed cost of exporting.

### 2.3 Timing

Figure 1 summarizes the timing within a period in the model. At time $t = 0$, exporters know their $\eta_i$’s, which are fixed over time. In addition to this information, at the beginning of each period, exporters see their productivity shocks, $\epsilon_{it}$, and cost shocks, $u_{it}$. Recall that importers cannot observe the $\epsilon_{it}$’s directly. After the realization of the productivity and cost shocks to each exporter, importers make offers, $\phi_{it}$, to each exporter $i$ at time $t$ according to their beliefs in that period.\(^7\) The importers’ offers, $\phi_{it}$, are made from their total endowment, $\omega_t$. Given the offer and the realization of the productivity and cost shocks, an exporter decides either to accept or reject the offer. If an exporter chooses to accept the offer, then importers pay their offer, $\phi_{it}$, to the exporter, and the exporter pays the cost of producing and exporting, $c_{it}$, and ships the output, $y_{it}$, to the home country. If an exporter chooses to reject the offer, then the exporter receives zero payment, and no cost is paid. Once the shipments of output arrive in the home country, importers update their beliefs based on the output received. Importers update

\(^7\)There is no renegotiation between importers and exporters in a given period. An interpretation of this assumption is that negotiation between firms engaged in international trade is costly and time consuming. Thus, renegotiation within a given period is prohibited.
their beliefs about those exporters who actually shipped goods and keep the same beliefs for those who did not ship goods.

2.4 Importers

There is a continuum of risk-neutral importers of measure $M$ in the home country with importers indexed by $m$. Importers are endowed with $\omega_t$ in each period and wish to exchange their endowment for the homogeneous good, $y$. In each period, representative importer $m$ makes a list of offers with one offer for each exporter. The representative importer $m$ chooses how much to offer each exporter according to the beliefs at that period, $\hat{\eta}_it$. The expected utility of importer $m$ at time $t$ for dealing with a particular exporter $i$ is given by

$$U_{it}^m = E_t[y_{it}] - \phi_{it},$$

where $E_t[\cdot]$ denotes the expectations with respect to the importer’s available information at the beginning of time $t$ and $\phi$ is the offer paid to the exporter.$^8$

Under risk neutrality, the competitive market equilibrium implies the market offer for each exporter $i$ will be

$$\phi_{it} (\Omega_{it}) = E[y_{it}|\Omega_{it}] = \mu_{\hat{\eta}_it} \forall i,t > 0,$$

$^8$An importer’s total utility is given by $\sum_{i=1}^I U_{it}^m$. We also assume $\sum_{i} \phi_{it} = \omega_t \forall t$, which implies importers have an exactly sufficient amount of endowment in each period.
where $\Omega_{it} = \{y_{ti}^{t-1}, \cdot\}$ and $y_{ti}^{t-1} = \{y_{i0}, \ldots, y_{it-1}\} \forall i, t > 0$.\footnote{At $t = 0$, $\phi_0 = \mu_{\hat{\eta}_0}$. Note that, because $E[\epsilon_{it}] = 0$, the productivity shocks, $\epsilon_{it}$, do not influence the optimal offers made by importers. From now on, we simply denote the importer’s information set about exporter $i$ as the history of output, $y_{ti}^{t-1}$.}

$\Omega_{it}$ denotes the information set available to importers about exporter $i$ at time $t$. The information set consists of the history of exporter $i$’s output up to time $t$, $y_{ti}^{t-1}$. Since importers update their beliefs according to exporter $i$’s output each period, their information sets are also updated. Importers only update their information set for an exporter if that exporter decides to accept the offer and ship an amount of goods to the home country. If an exporter decides not to accept the offer and not ship any goods, then importers do not update their information set for that particular exporter. $\Omega_{it}$ is always the same for all importers, as additional information received by representative importer $m$ in each period perfectly spreads among importers.

If an exporter accepts the offer and sends an amount of the good, $y_{it}$, then learning on the part of the importers results in normally distributed posterior beliefs, $\hat{\eta}_{it+1}$. The mean, $\mu_{\hat{\eta}_{it+1}}$, and precision, $h_{\hat{\eta}_{it+1}}$, of $\hat{\eta}_{it+1}$ are given by\footnote{This is a well-known learning formula resulting from the normality and independence assumptions. See, for instance, Holmstrom (1999).}

$$
\begin{align*}
\mu_{\hat{\eta}_{it+1}} &= \frac{\mu_{\hat{\eta}_{it}} h_{\hat{\eta}_{it}} + y_{it} h_\epsilon}{h_{\hat{\eta}_{it}} + h_\epsilon} \quad \text{and} \quad h_{\hat{\eta}_{it+1}} = h_{\hat{\eta}_{it}} + h_\epsilon,
\end{align*}
$$

where $h$’s denote precisions of the respective variables. If an exporter rejects the offer and does not send any goods, than importers will have the same beliefs next period:

$$
\begin{align*}
\mu_{\hat{\eta}_{it+1}} &= \mu_{\hat{\eta}_{it}} \quad \text{and} \quad h_{\hat{\eta}_{it+1}} = h_{\hat{\eta}_{it}}.
\end{align*}
$$

We choose to use precisions in equations (5) and (6) to simplify the discussion of results in section 4.

### 2.5 Exporters

There are a finite number of risk-neutral exporters operating independently of one another in the foreign country indexed by $i = 1, \ldots, I$. Each exporter potentially has a different productivity level, $\eta_i$, which is assigned to them at time $t = 0$ and remains fixed over time. Each exporter earns profits by selling the homogeneous good, $y$, in exchange for the importers’ endowment, $\omega$. 
We formulate the exporter’s problem recursively for expositional simplicity. At the beginning of a period, let \( v(\mu, h, \epsilon, u) \) be the optimal value of the problem for an exporter with \((\mu, h, \epsilon, u)\).\(^{11}\) \(\mu\) refers to the mean of the importers’ beliefs. By equation (4), it is clear that \(\phi = \mu\). We could either use \(\phi\) or \(\mu\) as a state variable. \(h\) refers to the precision of the importers’ beliefs. \(\epsilon\) and \(u\) are the realized productivity and cost shocks at a given period. The set \((\mu, h, \epsilon, u)\) summarizes the state variables for an exporter. Then, an exporter chooses whether to accept or reject the offer made by importers. The Bellman equation is given by

\[
v(\mu, h, \epsilon, u) = \max\{\pi + \int \int \beta v(\mu', h', \epsilon', u')dF(u')dG(\epsilon'), \int \int \beta v(\mu, h, \epsilon', u')dF(u')dG(\epsilon')\},
\]

subject to the constraints

\[
\pi \geq 0, \tag{8}
\]

\[
\mu' = \frac{h\mu + h\epsilon(\eta + \epsilon)}{h + h\epsilon}, \tag{9}
\]

\[
h' = h + h\epsilon, \tag{10}
\]

where \(\pi = \mu - f + u\). The fixed cost, \(f\); actual productivity, \(\eta\); and precision of the distribution of productivity shocks, \(h\epsilon\), are constant over time.

The maximization is over the two actions: (1) accept the offer or (2) reject the offer. The first term on the R.H.S. of equation (7) refers to the case of accepting. An exporter earns current profit, \(\pi\), and begins the next period facing importers with updated beliefs, \(\mu'\) and \(h'\). The second term on the R.H.S. of equation (7) refers to the case of rejecting. An exporter earns zero profit today and faces importers with the same beliefs, \(\mu\) and \(h\), during the next period. Successive draws of \(\epsilon\) and \(u\) are independent. \(F(u)\), the c.d.f. of \(u\), and \(G(\epsilon)\), the c.d.f. of \(\epsilon\), are independent of each other. There is no returning to earlier options. Equation (8) shows the nonnegativity condition for \(\pi\). Equations (9) and (10) show how \(\mu\) and \(h\) evolve over time.

**Lemma 1** If an exporter chooses to accept, then \(y = \eta + \epsilon\).

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\(^{11}\)We also formulate the problem sequentially in appendix A.

\(^{12}\)Note that WLOG we drop the \(i\)'s.
**Proposition 1:** Given Lemma 1 and \((\mu, h, \epsilon, u)\), an exporter chooses

\[
\begin{cases}
\text{Accept,} & \text{if } \pi \geq 0 \text{ and } \epsilon \geq \xi(\mu, \cdot) \\
\text{Reject,} & \text{otherwise}
\end{cases}
\]  

(11)

**Proposition 2:** \(\xi(\mu, \cdot)\) is decreasing in \(\mu\).

**Proofs:** See appendix A.

Lemma 1 clearly shows that if an exporter satisfies the conditions for accepting, then in order to build a good reputation in the shortest amount of time or to hide its bad productivity as long as possible, an exporter ships all the goods produced in a given period of time.

Proposition 1 is one of the main results of this paper. It captures the strategic choices made by exporters concerned with how current decisions affect their reputations and, thus, future profits. Consider the case when exporters make positive profits at a given time. Exporters still have to decide whether to enter the market or not, because they not only care about their current profits but their reputations, which affect future profits. For instance, if the current realization of the productivity shock is sufficiently low such that accepting and shipping the goods, \(y\), would affect the importers’ beliefs in a negative way, then an exporter \(i\) may not choose to send the good, despite earning current positive profits. An exporter must weigh the current profit gain versus the discounted expected loss from future profits resulting from a negative reputation. Clearly, if the latter is greater, then an exporter chooses to reject even in the case of positive profits. Hence, \(\xi\) is the productivity threshold level which equates the value of the discounted expected lifetime profit streams in the cases of accepting and rejecting.

Proposition 2 shows that an increase in the mean of the beliefs, \(\mu\), in a given period of time decreases the threshold productivity. By equation (4), an increase in \(\mu\) increases the offer importers make to an exporter. This result is crucial for the decision of an exporter deciding whether to accept or reject. Intuitively, if an exporter has a better reputation, then it can withstand worse shocks. In other words, an exporter who already established a good name in the market can choose to accept and send the goods even with a lower productivity shock.
3 The Case of U.S. Car Imports from Japan and France

In the above analysis, we introduced a mechanism stressing the importance of asymmetric information, learning, and reputation in international trade. We now use our model to study two contrasting bilateral trade flows, namely United States imports of Japanese and French passenger cars over the period 1961-2005. We choose to study these particular trade flows for two reasons. First, the automobile sector is a large and important sector in international trade. In the case of United States imports, passenger cars accounted for as much as 12.5% of total imports over the period 1961-2005. Second, asymmetric information, reputation, and learning occupy a leading role in explaining the evolution of these trade flows, especially in answering why Japanese and French cars had such different experiences in the United States market.\(^\text{13}\)

3.1 Japan

Figure 2 shows United States passenger car imports from Japan over the period 1961-2005 from the OECD’s International Trade by Commodity Database. Very few Japanese cars were exported to the United States before the 1970’s. At the time, American consumers showed little interest in the lightweight compact cars coming from Japan, preferring instead the larger models produced by GM, Ford, and Chrysler, the so-called Big Three of automobile production. During the oil crises of 1973 and 1979, though, American consumers began to show an interest in the fuel efficient Japanese cars. As consumers learned more about the new Japanese cars, they discovered not only were the cars fuel efficient, but they were also well-built and reliable vis-à-vis their American rivals. Wojcik (2001) studies American consumer learning about a particular model, manufacturer, or Japanese cars in general during the 1970’s, the period of the oil crises, and the 1980’s. Wojcik (2001) uses a data set in which approximately 9% of households buy new cars each year. The share of new cars accounted for by Japanese imports increases from 5.7% in 1971 to 26.1% in 1990, averaging 15.4% over the entire period. Wojcik (2001) finds all three sources of learning impacted the demand for individual Japanese cars in the American market and were significant factors in the increase in overall Japanese market share.

\(^{13}\)In the case of Japan, see Mannering and Winston (1991), Train and Winston (2007), Wojcik (2001), and, for recent treatments in the popular press, Crandall and Winston (2005) and Gertner (2007). For France, see Archawski and Wolek (1995).
The oil crises of the 1970’s gave the Japanese exporters the opportunity to signal to American consumers about their cars and begin the process of building a reputation. In the years since the oil crises, the reputation of Japanese cars consistently ranked among the highest in the automobile industry, as publications like *Consumer Reports* clearly attest. Mannering and Winston (1991) documents that consumer brand loyalty, one potential measure of reputation, towards Japanese produced cars relative to American produced cars grew during the years after the oil crises. Mannering and Winston (1991) shows this brand loyalty explains a significant fraction of the increase in Japanese market share in the 1980’s American automobile market.

Through this signaling and learning process, United States car imports from Japan increased dramatically after 1975, as shown in figure 2. In addition, Wojcik (2001) documents total sales of Japanese cars in the United States as increasing by 427% over the years 1971-1990, while total new car sales increased by only 9%. Total sales numbers for Japanese cars from 1971 to 1990 are primarily being driven by imports, since Japanese manufacturers did not begin setting up factories in the United States until the mid-1980’s.

In the language of our model, Japanese exporter $i$’s actual productivity level, $\eta_i$, is high. However, Japanese exporters face American importers with such low prior beliefs, $\hat{\eta}_{i0}$, in the years before the oil crises that Japanese exporters choose not to export. Eventually, the Japanese
exporters in the model face cost shocks good enough such that they are able to export. We interpret the good cost shocks as the oil crises and a means by which Japanese exporters are able to signal to American importers about themselves, despite initially being faced with unfavorable beliefs on the part of American importers. Once American importers receive and consume a shipment of exporter \( i \)'s goods, they update their beliefs, which affects future decisions made by the Japanese exporters. In this way, Japanese exporters eventually enter the American market and continue to export thereafter.

Figure 3 compares a sample trade flow simulation of our model,

\[ \sum_{i=1}^{I} y_{it} \forall t, \]

(12)

with the actual trade flow data on United States imports of Japanese cars over the years 1961-2005. We use two alternative methods for conducting the simulation appearing in figure 3, one of which is a maximum likelihood method. Both methods generate similar results. These methods allow us to pin down the parameter values governing two crucial relations for the simulations. The first relation is between the actual productivity level, \( \eta \), and the mean of the prior beliefs, \( \mu_{\hat{\eta}_0} \). The second crucial relation is between the mean of the initial prior belief, \( \mu_{\hat{\eta}_0} \),
and the mean of the initial ex-ante cost distribution, $\mu_c$. When using the maximum likelihood method, we maximize the likelihood of not entering the market for $\tau$ periods, entry in the $(\tau + 1)$th period, and always being in the market thereafter for each exporter. The result of this maximum likelihood method helps us to identify the parameters for the two crucial relations. Complete details for our simulations appear in appendix B. Returning to figure 3, the model replicates both the period of low imports before the 1970’s oil crises and, once the oil crises occur, the subsequent years of increasing imports. All in all, figure 3 shows our model is capable of matching the data well.

However, figure 3 presents one sample trade flow simulation of our model. In order to test the reliability of this result, we construct a test of robustness. Figures 4 and 5 report our robustness results. These figures are constructed by repeating the simulation 10000 times, which requires generating a new series of random shocks for $\epsilon$ and $u$ for each simulation. We then report the average of each year’s 10000 simulation results. We also calculate the standard deviations for each year’s 10000 simulation results and, then, add and subtract two standard deviations from each year’s average to construct a confidence interval. These bands measure the robustness of

\footnote{In the maximum likelihood method, this is true for all shocks, but, in our other method, we choose the $u$ shock during the oil crises. See appendix B for details.}
our results.

### 3.2 France

Figure 6 shows United States passenger car imports from France over the period 1961-2005 from the OECD’s International Trade by Commodity Database. Very few French cars were exported to the United States prior to the 1970’s. As in the case with Japan, the oil crises of the 1970’s gave French exporters the chance to enter the American market. Once given the chance to enter the American market, French exporters had the opportunity to signal to American consumers about their cars and begin the process of building a reputation. The French cars established a reputation thereafter. Unlike the Japanese, however, French cars became known not for their reliability but for their chronic need to be taken to the repair shop. The impact of learning and reputation on imports of French cars to the United States was exactly the opposite as that in the Japanese case. Instead of imports of French cars continuing to increase after the effects of the oil crises subsided, imports decreased as sharply as they had increased, as can be seen in figure 6. Imports of French cars actually decreased to a level lower than the one prior to the oil crises. Indeed, figure 6 shows imports of French cars virtually stopped after 1990.
In the context of our model, the French case is similar to the Japanese. French exporters face American importers with such low prior beliefs, $\tilde{\eta}_0$, that French exporters choose not to export. Eventually, however, French exporters face cost and productivity shocks good enough such that they are able to export. Again, we interpret the good cost and productivity shocks as the oil crises. The good shocks serve as a way for French exporters to signal to American importers, despite the fact that American importers initially have unfavorable beliefs about the French exporters. American importers update their beliefs about French exporter $i$ after seeing the exporter’s goods. Unlike the Japanese exporters, though, French exporter $i$’s actual productivity level, $\eta$, is low. As a result, once the effects of the good cost and productivity shocks are eliminated, American importers learn about the low productivity, which affects future decisions made by the French exporters. French exporters again face American importers with such unfavorable beliefs that they choose not to export. In this manner, American importers import French cars during the oil crises but then decrease their imports after learning about the French cars.

Figure 7 compares the actual data of United States imports of French cars over the years 1961-2005 with equation (12), a sample trade flow simulation from the model. The model is
Figure 7:
Model Simulation: United States Imports of French Passenger Cars

Figure 8:
Model Simulation: French Robustness
capable of capturing both the increased imports during the period affected by the oil crises and the years of low imports before and after the oil crises. Again, we report our measure of robustness in figures 8 and 9. The construction of figures 7, 8, and 9 is discussed in appendix B.

4 Additional General Results

In order to analyze the impact of asymmetric information, learning, and reputation on international trade patterns, we show the importance of differentiating between the short run and long run. This differentiation is crucial in terms of understanding trade patterns seen in the data and the implications of trade policies, such as import tariffs and export subsidies, in a world characterized by asymmetric information. We organize all the results in this section around numerical simulations of the model, the details of which are described in appendix C.

4.1 Short Run vs. Long Run

As in closed economies, asymmetric information can cause adverse selection problems in international markets in the short run. As time passes, a “reduced information problem” can be a
solution to adverse selection. In the context of our model, any additional information achieved by the signals from exporters will aid importers in their learning process and help importers to update their information sets.

In the long run, importers’ beliefs converge to the actual values of each exporter’s productivity, \( \eta_i \). This implies \( \eta_i \) will be fully known in the limit. As a result, in the long run, relatively more productive exporters end up with larger amounts of exports. Relatively less productive exporters will still export but in relatively smaller amounts. A subset of these relatively less productive exporters will end up not exporting at all. These long run results are not different from existing trade literature and match those of Melitz (2003). However, in the short run these trade patterns can be potentially different.

In order to better understand this result, consider an example in which there are two types of exporters: exporters of type \( \eta^H \) have high productivity, and those of type \( \eta^L \) have low productivity. There are potentially many exporters of each type. The exporters’ productivity levels are incompletely known by importers. Exporter \( \eta^H \) is relatively more productive than exporter \( \eta^L \), but this may not be true in terms of beliefs. Suppose at time \( t = 0 \) the imperfect information is such that importers believe exporters of type \( \eta^L \) are relatively more productive than \( \eta^H \).

Given these conditions, the model predicts the trade flows depicted in figure 10. Exporters of type \( \eta^L \) start with exporting a relatively higher amount due to the importers’ beliefs, which result in higher offers. But, as time passes, the amount of type \( \eta^L \)'s exports decreases. This occurs through importers learning about the actual productivity of exporters of type \( \eta^L \), which in turn decreases the offers for these exporters. At the same time that the exports by type \( \eta^L \) are decreasing, the exports by type \( \eta^H \) are increasing due to a similar learning and reputation building mechanism. Once importers are able to learn about exporters of type \( \eta^H \), the offers made to these exporters increase. As a result of these two effects, the trade patterns switch over time. Figure 10 shows the exporters of both types converging to a long run pattern, but the transition to these long run patterns, that is, the short run trade patterns, can be dramatically different due to asymmetric information, leading to an adverse selection problem. In the short run, importers are largely importing from exporters of type \( \eta^L \), instead of \( \eta^H \). Over time, though, this adverse selection problem is solved. Signals by \( \eta^H \) exporters reveal more and
more information, and type $\eta^H$ exporters build a stronger reputation. Eventually, goods from exporters of type $\eta^H$ dominate the trade flows.

We can use this result to further our discussion of United States imports of Japanese Cars. Since this paper develops a model of international trade, it is natural to study a significant bilateral trade relationship. The other side of the story about United States imports of Japanese cars is, of course, the oft-lamented decline in the competitiveness of the American automobile industry. The same *Consumer Reports* documenting the positive reputation of most Japanese cars documents the negative reputation of many American cars. The gap between American consumers’ beliefs about Japanese and American cars is not improving. Indeed, Crandall and Winston (2005) compares annual issues of *Consumer Reports* in 1985 and 2005 suggesting this fact. In 1985, American consumers who purchased American cars were six times more likely to need “worse than average” or “much worse than average” car repairs than those consumers owning Japanese cars. American cars were still five times more likely than Japanese cars to need major repairs in 2005.

Reputation and consumer beliefs have their consequences. Figure 11 presents data taken from Train and Winston (2007) on American and Japanese market share of car sales in the United States.
In the context of the model, if we consider American and Japanese manufactures as exporters trying to sell to importers, or American consumers, then the above result helps to understand figure 11. Notice the relation between figures 10 and 11. Recall figure 10 shows total exports of low and high productivity exporters. Importers’ beliefs are such that low productivity firms dominate the market initially and only later do high productivity firms enter the market and eventually dominate. With American manufactures being the low productivity firms and Japanese manufactures being the high productivity firms, figure 10 provides a possible explanation for figure 11. Although figure 11 shows Japanese market share in 2005 as still being 2% lower than American, it seems almost certain that the “switching” in relative positions seen in figure 10 will occur, especially in light of such news as Toyota overtaking General Motors as the largest car manufacturer for the first time in 2007. A similar switching has already occurred in the market shares of total vehicle sales in the United States, as the share of vehicle sales due to non-American vehicles passed the share due to American for the first time in history in 2008. Whatever the future holds for American car manufacturers, our model suggests influencing consumers’ beliefs by rebuilding a good reputation will be necessary if the trends

\[\text{Figure 11: American and Japanese Market Share of Car Sales in the United States}\]

\[\text{\textsuperscript{15}We only include American and Japanese manufacturers. As a result, the shares do not sum to 100.}\]

\[\text{\textsuperscript{16}See Bradsher (2007) for reporting on this event.}\]
seen in figure 11 are to be reversed.

4.2 Speed of Learning and Reputation Building

The learning and reputation process in our model depends on how the importers’ beliefs evolve over time. As a result, the manner in which the beliefs change will influence the trade patterns predicted by the model. How the importers’ beliefs evolve depends on the nature of the good being exported. Different sectors are associated with different learning and reputation processes. For example, Shapiro (1983) points out that beliefs about cars change only slowly. Consumers do not completely change their beliefs about a car manufacture after one period. The consumers partially adjust their beliefs, giving weight not only to what they see as their new car but also to their previously held beliefs. This occurs because certain attributes of a car, like its durability, are difficult, if not impossible, to immediately detect. Over time, these beliefs change as the car is used. An example of a sector associated with rapid learning and reputation processes is the agricultural goods sector. Consumers can easily inspect and discern the nature of the good by tasting the food or beverage, updating their beliefs immediately.

In our model, we capture the learning and reputation process associated with a sector $j$ by the initial ratio of the precision of the importers’ beliefs to the precision of the idiosyncratic productivity shock, $H_0(j) = \frac{\hat{\eta}_{i0}(j)}{\hat{\epsilon}(j)}$, where $H_0(j) \in (0, \infty)$. As a result, when using equation (5) to update their beliefs for the next period, importers attach weights $\hat{\eta}_{i0}(j)$ and $\hat{\epsilon}(j)$ to their prior beliefs and the exporter’s signal, respectively. $H_0(j) = 1$ corresponds to the case when importers attach equal weights to their prior beliefs and the exporter’s signal, while $H_0(j) > 1$ ($H_0(j) < 1$) corresponds to when importers attach relatively more (less) weight to their prior beliefs.

Sectors in which importers place relatively more weight, $\hat{\eta}_{i0}(j)$, on their prior beliefs are those with a relatively high $H_0(j)$. Learning and reputation building occur relatively slowly over time in these sectors, as in the car example above. Sectors in which importers place relatively less weight, $\hat{\eta}_{i0}(j)$, on their prior beliefs are those with a relatively low $H_0(j)$. Learning and reputation building occur relatively faster in these sectors, as in the agricultural goods example above.

Figure 12 shows how the model’s predicted trade patterns change with changes in $H_0$. The
higher $H_0$ is, the slower is the increase in total exports. Figure 12 reports one measure capturing the difference in the speed at which total exports increase, namely the number of periods required to transition from 5% to 50% of the maximum level of total exports.

4.3 Information and Trade Policies

We now extend the basic model from section 2 to incorporate trade barriers and export subsidies. In addition to the traditional increase or decrease in the volume of trade, our model highlights another dimension of trade barriers and export subsidies, namely their effect on the extent of asymmetric information existing between importers and exporters.

In order to measure the extent of these information problems in our model, we need to identify the relation between importers’ beliefs and exporters’ true characteristics. After the realization of output at the end of time $t$, $\hat{\mu}_i = \kappa_{it}$, which potentially may be different than 1. $\kappa_{it}$ can be interpreted as a measure of informational problems among importers and exporter $i$ at time $t$. The further $\kappa_{it}$ is from 1, the more information problems there are between importers and exporter $i$. $\kappa_{it} > 1$ corresponds to the case when importers undervalue exporter $i$. $\kappa_{it} < 1$ corresponds to the case when importers overvalue exporter $i$. $\kappa_{it}$ is an important dimension in international trade which we study under three different trade policy regimes: trade barriers,
export subsidies, and free trade with no export subsidies.

Among other things, trade barriers can be thought of as import tariffs or transportation costs, the former incurred by importers and the latter incurred by exporters. In the context of our model, we view these trade barriers as a friction which reduces the offer received by an exporter. In the case of an import tariff, importers pay some share of their offer \( \phi_{it} \) as a tariff. The importers’ new offers including the tariff payment can be denoted as \( \tilde{\phi}_{it} \) and will necessarily be lower than \( \phi_{it} \).

In the case of transportation costs, exporters pay some amount from \( \phi_{it} \) to ship their goods to the home country, hence the portion left over as profit can be denoted \( \tilde{\phi}_{it} \). Instead of drawing a distinction between these two types of trade barriers, we simply model trade barriers as some fixed payment, \( \psi \), taken from \( \phi_{it} \).

Government export subsidies can also be used to affect trade patterns and the extent of asymmetric information between importers and exporters. We do not explicitly model a government’s problem in this section but consider export subsidies exogenously available to the foreign country exporters. In terms of the exporter’s problem, an export subsidy can be modeled as a fixed amount, \( \psi \), subtracted from the exporter’s cost of exporting, \( c_{it} \). We can then denote the

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17 Recall that importers’ optimal offers without tariffs at time \( t \) for each exporter \( i \) is given by equation (4).
cost of exporting under an export subsidy as $\tilde{c}_{it}$, which is necessarily lower than $c_{it}$.

Figure 13 compares the informational environment under the three different policy regimes by reporting the $\kappa$’s associated with each regime. Figure 13 reports an average aggregate measure of $\kappa$. Trade barriers increase information problems, since it is more difficult for exporters to enter the market to begin with. Export subsidies, however, decrease the informational problems between importers and exporters. To the best of our knowledge, this is not an aspect of export subsidies which is often considered when discussing policy implications.

5 Conclusion

We have attempted to enrich the study of international trade theory by developing a framework which casts asymmetric information, learning, and reputation as the leading roles. In our framework, international trade takes place when exporters accept belief-based offers from importers in exchange for shipments of exporters’ goods. Importers then update their beliefs according to signals derived from the arrival of the exporters’ goods. These new beliefs determine the new offers made to exporters and, consequently, affect the subsequent decision of whether to export. As a result, learning and reputation building change the informational environment in which importers and exporters interact and, thus, have a direct effect on the determination of international trade patterns.

The most obvious, yet important, implication of our framework for the study of international trade is that a firm’s ability to export depends not only on its characteristics but also on what importers believe about those characteristics. The history of Japanese and French car exports to the United States reflects this main idea. Existing literature and available evidence create a compelling case for asymmetric information, learning, and reputation to be at the heart of any explanation of Japanese and French car imports. We show our model is capable of replicating the experience of United States car imports from Japan and France over the period 1961-2005.

In addition to deepening our understanding of these events, we discuss further implications of our framework. Since learning and reputation building require time, our model forces us to also take seriously the difference in short run and long run trade patterns. The long run results of our model match those of Melitz (2003), but the short run results can be quite different. We
show how sectorial differences in the speed of learning and reputation building affect predicted trade patterns. The extent of asymmetric information existing between importers and exporters also changes under different trade policies, and we compare the free trade, trade barrier, and export subsidy cases of our model.
Appendix

Appendix A: Proofs of Lemma 1 and Propositions 1 and 2

Proof of Lemma 1:

The offer (4) and learning (5) equations together imply that offers at time \( t + 1 \) are strictly increasing in the amount of \( y \) exported at time \( t \). Clearly, profit is strictly increasing in the offer (and recall that \( f \) is independent of \( y \)). Finally, the exporter’s objective function is strictly increasing in profits. Taken together, these imply \( y_t = \eta_i + \epsilon_{it} \) under the decision to accept.

Proof of Proposition 1:

The sequential version of the exporter’s problem can be written as follows: For \( t = \tau \), given the offer (4) and the learning process (5) and (6), an exporter \( i \) solves \( \max \{ A_{i\tau}, R_{i\tau} \} \) subject to the constraints \( A_{i\tau} = \pi_{i\tau}(y_{i\tau}^{\tau-1}) + \beta E_{\tau}[\pi_{i\tau+1}(y_{i\tau}^{\tau})] + \ldots \), \( R_{i\tau} = 0 + \beta E_{\tau}[\hat{\pi}_{i\tau+1}(\hat{y}_{i\tau}^{\tau})] + \ldots \), and also subject to nonnegative profits for every period. Profits in the case when an exporter accepts are \( \pi_{i\tau}(y_{i\tau}^{\tau-1}) = \phi_{i\tau}(y_{i\tau}^{\tau-1}) - c_{i\tau} \). In the case when an exporter rejects, profits are \( \pi_{i\tau}(y_{i\tau}^{\tau-1}) = 0 \).

Similarly, the cost of exporting when an exporter accepts is given by \( c_{i\tau} = f - u_{i\tau} \). When an exporter rejects, \( c_{i\tau} = 0 \). At \( t = \tau \), an exporter \( i \) chooses whether to accept or reject given the offer (beliefs of importers) and realized shocks \((\epsilon, u)\). \( A \) and \( R \) are the expected discounted lifetime profit streams in the cases of accepting and rejecting, respectively. \( \pi \) and \( \hat{\pi} \) refer to the profits in the cases of accepting and rejecting. Since the exporter solves the problem at \( t = \tau \) conditional on the information at \( \tau \), expectations are conditional on \( \tau \).

Given the problem above, we define \( u_{\pi_{i\tau}=0} \) as the threshold for zero profits at time \( \tau \). If \( u_{i\tau} \geq u_{\pi_{i\tau}=0} \), then \( \pi_{i\tau} \geq 0 \), and if \( u_{i\tau} < u_{\pi_{i\tau}=0} \), then \( \pi_{i\tau} < 0 \). Given the offer and \( f \), \( u_{\pi_{i\tau}=0} \) can be obtained from \( \pi_{i\tau}(y_{i\tau}^{\tau-1}) = \phi_{i\tau}(y_{i\tau}^{\tau-1}) - f + u_{i\tau} \). \( \xi_{i\tau} \) is the threshold productivity shock defined by the following: if \( \epsilon_{i\tau} \geq \xi_{i\tau} \), then \( A \geq R \), and if \( \epsilon_{i\tau} < \xi_{i\tau} \), then \( A < R \).

There are potentially four different cases. We first summarize the results of the different cases and then prove the results in the remainder of the appendix. For both of the cases when \( u_{i\tau} < u_{\pi_{i\tau}=0} \), the nonnegative profit constraint binds, and exporter \( i \) rejects the offer.\(^{19}\) For the case \( u_{\pi_{i\tau}=0} < u_{i\tau} \) and \( \epsilon_{i\tau} \leq \epsilon_{i\tau} \), exporter \( i \) realizes nonnegative profits during the current period

\(^{18}\)We suppress \( y_{i\tau}^{\tau-1} \) from now on.

\(^{19}\)Specifically, the first case is \( u_{i\tau} < u_{\pi_{i\tau}=0} \) and \( \epsilon_{i\tau} < \epsilon_{i\tau} \), and the second case is \( u_{i\tau} < u_{\pi_{i\tau}=0} \) and \( \epsilon_{i\tau} \geq \epsilon_{i\tau} \).
and anticipates a higher expected discounted lifetime profit stream from accepting compared to rejecting. As a result, exporter $i$ accepts the offer in this case. In the last case, $u_{pi_t=0} < u_{it}$ and $\varepsilon_{it} > \epsilon_{it}$, exporter $i$ has nonnegative profits during the current period, but the expected discounted lifetime profit stream from accepting will be lower than that from rejecting. Intuitively, an exporter $i$ can make nonnegative profits by accepting the offer but will affect its reputation in such a way that the current gain from profits will not compensate the future loss caused by a bad reputation. Exporter $i$ rejects the offer in this case.

In order for the decision of accepting to be optimal, two conditions have to be satisfied at time $\tau$. First, clearly, the nonnegativity condition for profits, $\pi_{i\tau} \geq 0$, must hold. Second, the R.H.S. of the following equation also has to be greater than or equal to the L.H.S. (i.e. $R \leq A$):

$$0 + \beta \cdot E_{\tau} [\hat{\pi}_{i\tau+1}] + \beta^2 \cdot E_{\tau} [\hat{\pi}_{i\tau+2}] + ... \leq \pi_{i\tau} + \beta \cdot E_{\tau} [\hat{\pi}_{i\tau+1}] + \beta^2 \cdot E_{t} [\hat{\pi}_{i\tau+2}] + ...$$

(13)

Given the fixed parameters, realized $u_{i\tau}$, and an offer at time $\tau$, $\epsilon_{i\tau}$ determines whether the R.H.S. or L.H.S. of (13) is greater. The R.H.S. of equation (13) is strictly increasing in $\epsilon_{i\tau}$, and the L.H.S. is independent of $\epsilon_{i\tau}$. Hence, there exists a unique $\epsilon_{i\tau}$ which equates L.H.S and R.H.S.

Figure 14 shows the curves for the cumulative expected discounted profit across time under different $\epsilon_{i\tau}$’s. The final end points of the curves correspond to the finite values of the expected discounted lifetime profit streams. In figure 14, $\epsilon_{i\tau}^1 > \epsilon_{i\tau}^2 > \epsilon_{i\tau} > \epsilon_{i\tau}^3$.

Now, let’s look at why R.H.S. is strictly increasing in $\epsilon_{i\tau}$. A higher $\epsilon_{i\tau}$ corresponds to a higher
\( y_{\tau} \), which means, by equation (5), higher \( \epsilon_{\tau} \)'s correspond to a higher offer at time \( \tau + 1 \). As a result, a higher \( \epsilon_{\tau} \) corresponds to a higher expected discounted profit at time \( \tau + 1 \). Moreover, a higher offer in expected terms at time \( \tau + 1 \) corresponds to a higher offer at time \( \tau + 2 \) in expected terms. As a result, a higher \( \epsilon_{\tau} \) also corresponds to a higher expected discounted profit at time \( \tau + 2 \). The same reasoning holds for future periods. Hence, this result shows that a higher \( \epsilon_{\tau} \) corresponds to a higher cumulative expected discounted profit curve in figure 14. Notice that all curves begin at the same value on the y-axis in the case of accepting, since \( \epsilon_{\tau} \) does not affect the profit at time \( \tau \). The curve corresponding to \( \epsilon_{\tau}^1 \) is higher than that corresponding to \( \epsilon_{\tau}^2 \). As \( \epsilon_{\tau} \) becomes lower, the corresponding curve lowers in figure 14 as well. At some point, the curve corresponding to \( \epsilon_{\tau} \), which we denote \( \xi_{\tau} \), converges to the reject curve. Recall that the reject curve is independent of \( \epsilon_{\tau} \). \( \epsilon_{\tau} \) makes equation (13) hold with equality.

\( \epsilon_{\tau}^3 \), which is lower than the threshold, \( \xi_{\tau} \), makes the R.H.S. less than the L.H.S. in equation (13). The curve corresponding to \( \epsilon_{\tau}^3 \) shows the acceptance (notice that acceptance is not optimal) case in which \( \epsilon_{\tau} < \xi_{\tau} \). Under this condition, current profits at time \( \tau \), seen in figure 14 as the intersection with the y-axis, are greater than zero for \( \epsilon_{\tau}^3 \) and equal to zero for the reject curve. At some point, the reject curve crosses the \( \epsilon_{\tau}^3 \) curve and remains above thereafter. At time \( \tau + n \), at which point the reject curve crosses the \( \epsilon_{\tau}^3 \) curve, the expected offer for the reject case has to be greater than the expected offer for the acceptance case. This guarantees the reject curve remains above the \( \epsilon_{\tau}^3 \) curve by the same reasoning in the previous case above. Since the reject curve converges to a higher value than the \( \epsilon_{\tau}^3 \) curve (i.e. higher expected discounted lifetime profit), rejecting is the optimal decision for exporter \( i \) in the case in which \( u_{\pi_{\tau}=0} < u_{it} \) and \( \xi_{it} > \epsilon_{it} \). Similarly, for the case when \( \pi_{\tau} \geq 0 \) and \( \epsilon_{\tau} = \xi_{\tau} \), accepting and exporting is optimal, because the discounted expected lifetime profit is greater than that when rejecting.

**Proof of Proposition 2:**

To prove proposition 2, we already know that given the offer and the fixed parameters, including the realized \( u_{i\tau} \), there exists a threshold \( \epsilon_{\tau} \) which equates equation (13). Fixing other parameters constant, increasing the mean of the beliefs, \( \mu_{\eta_{\tau}} \), at time \( \tau \), increases the R.H.S. more than the L.H.S. at time \( \tau \). Since L.H.S. is independent of \( \epsilon_{\tau} \) and R.H.S. is strictly increasing in \( \epsilon_{\tau} \) the new threshold equating equation (13) is smaller.
Appendix B: Japanese and French Numerical Simulations

This section explains how to choose parameters to run example simulations to compare with data on United States imports of Japanese and French cars over the years 1961-2005. Data used in determining the parameters of the model are collected from the OECD’s International Trade by Commodity Database, the Japan Automobile Manufacturers Association, and corporate websites of individual Japanese and French manufacturers. For simplicity, we set the variances of the productivity shocks, $\sigma_{\epsilon}^2$; cost shocks, $\sigma_{u}^2$; and initial prior beliefs, $\sigma_{\hat{\eta}}^2$, equal to one another and denote them by $\sigma^2$ for both simulations. Dropping this simplification does not change any of the results.

There are two crucial relations for these simulations. The first relation is between the actual productivity level, $\eta$, and the mean of the prior beliefs, $\mu_{\hat{\eta}}$:

$$\eta = \mu_{\hat{\eta}} + \theta_1,$$

where $\theta_1 \in \mathbb{R}$. $\theta_1 > 0 (< 0)$ corresponds to the case where the importers undervalue (overvalue) exporters. $\theta_1 = 0$ corresponds the case with no informational asymmetries.

The second crucial relation is between the mean of the initial prior belief, $\mu_{\hat{\eta}}$, and the mean of the initial ex-ante cost distribution, $\mu_c$:

$$\mu_{\hat{\eta}} = \mu_c + \theta_2,$$

where $\theta_2 \in \mathbb{R}$. We refer to the cost distribution before the realization of $u_t$ as the ex-ante cost distribution. Note that given the distributions of the cost shocks and prior beliefs, the initial ex-ante cost distribution will be normally distributed with mean $f$ and variance $\sigma^2$. The more negative (positive) $\theta_2$ is, the lower (higher) is the probability of getting an initial offer greater than cost and, thus, having the chance to enter the market. For both simulations, we set $\eta_i = \eta$.

For the Japanese case, in order to identify $\theta_1$ and $\theta_2$, we first use the average of the last 15 data of U.S. imports of Japanese cars to identify $\eta$: $\eta = \frac{\text{Avg. data of 91-05}}{I}$, where $I = 9$ is the number of Japanese exporters seen in the data. Given that importers initially undervalue the Japanese cars such that there are almost no imports before the oil crises, we have $\theta_1 > 0$ and $\theta_2 < 0$. We set $\theta_1 = 10\sigma$ in order to capture the dramatic difference between the prior beliefs and the actual productivity of Japanese exporters. We set $\theta_2 = 3\sigma$ to capture the fact that there
were almost no imports before the oil crises. For the years during the oil crises, we exogenously set \( u \) to be sufficiently high so that an exporter can enter the market. Clearly, before and after the oil crises, \( u \) is again a random shock in the model simulation. We also ran our simulations for Japan using an alternative method other than fixing the shocks for the years of the oil crises. We used a maximum likelihood method to find the optimal \( \theta_1 \) and \( \theta_2 \). We found \( \theta \)'s such that firms were most likely to enter the market during the years of the oil crises. We obtain similar results with both methodologies. Details of this alternative methodology appear below at the end of appendix B.

Since \( \sigma_{\epsilon}^2 = \sigma^2_{\epsilon 0} = \sigma^2_{u} = \sigma^2 \), which implies the variance of the initial ex-ante cost distribution, \( \sigma^2_{\epsilon} \), is also equal to \( \sigma^2 \), the choice of \( \sigma \) is just a normalization. We set \( \sigma \) equal to 200. Then, we calculate the exact values of \( \theta_1 \) and \( \theta_2 \). We set \( \beta = 0.99 \). Now we have all the parameters used in the Japanese simulations: \( \eta = 3122, \mu_{\eta 0} = 1122, \sigma = 200, \beta = 0.99, \mu_{\epsilon} = 0, \mu_{u} = 0, f = 1722, T = 45, \) and \( I = 9 \).

For the French case, we follow a similar method to that used in the Japanese case. The only differences are as follows: First, importers overvalue the French cars, and, as a result, \( \theta_1 < 0 \). Second, \( I = 5 \), which we take from data as before. We again set exogenous shocks for the French case during the years of the oil crises and relax this before and after the oil crises. We use the following set of parameters for the French case: \( \eta = 2, \mu_{\eta 0} = 1122, \sigma = 200, \beta = 0.99, \mu_{\epsilon} = 0, \mu_{u} = 0, f = 1722, T = 45, \) and \( I = 5 \).

**Alternative Japanese Numerical Simulation: Maximum Likelihood Method**

In order to find \( \eta, \mu_{\epsilon}, \) and \( \mu_{\eta 0} \), we identify \( \theta_1 \) and \( \theta_2 \) for the case of US-Japan bilateral car trade. We use a maximum likelihood method to identify these parameters. The likelihood function is as follows:

\[
L = \prod_{i=1}^{I'} (\alpha_1^{\tau_i})(1 - \alpha_1)(1 - \alpha_2) \cdots (1 - \alpha_{iT-\tau_i}),
\]

where \( I' = \text{number of actual exporters}, \alpha = \text{probability of the cost being greater than the offer/not entering the market during a given period}, \tau_i = \text{number of periods before exporter } i\text{ enters the market}, \) and \( T = \text{total time periods} \). Note that \( \alpha \) is the parameter in the likelihood function.
function related to the parameters $\theta_1$ and $\theta_2$.

Intuitively, the first term in the likelihood function, $\alpha_{\tau i}^1$, captures the first $\tau_i$ periods in which exporter $i$ is out of the market. Notice that this probability is not changing across exporters and periods until the first entrance into the market, because no updating has occurred yet. Since each exporter potentially enters the market in different periods, $i$ indexes $\tau$. The second term, $(1 - \alpha_1)$, corresponds the $(\tau + 1)$th period when an exporter enters the market for the first time. The other terms correspond to the case when once exporters enter the market, they always stay in. All the $\alpha$'s, except $\alpha_1$, are potentially different for each period and each exporter due to the updating mechanism (5). $\theta_2$ closely relates to $\alpha_1$. A high $\theta_2$ will increase the chance of entering the market, which corresponds to a low $\alpha_1$. $\theta_1$ relates to all $\alpha$’s other than $\alpha_1$. A high $\theta_1$ decreases the probability of not entering the market after the first entrance, which corresponds to the $\alpha$’s other than $\alpha_1$ being low.

Given data collected on the entry dates of Japanese exporters into the American market, the $\tau$ for each exporter, we maximize the likelihood of not entering the market for $\tau$ periods, entry in the $(\tau + 1)$th period, and always being in the market thereafter for each exporter. Given each exporter’s data, maximum likelihood returns the optimal $\alpha^*$’s. Given the optimal $\alpha^*$’s, $\alpha_1^*$ gives $\theta_2$ in terms of $\sigma$, and the other $\alpha^*$’s give $\theta_1$ in terms of $\sigma$. In short, what we do is first identify the $\alpha$’s, then find the corresponding values of the $\theta$’s in terms of $\sigma$. Using the entry data, we find $\alpha_1^* \approx 0.98$, and clearly all other $\alpha^*$’s are equal to zero. By using the solution to $\alpha_1^*$, the distance between $\mu_{\eta_0}$ and $\mu_c$ must be $\approx 2 \cdot \sigma$, so we set $\theta_2 = +2 \cdot \sigma$. The other $\alpha^*$’s tell us the probability of not entering the market after the first entrance is zero. This implies that the posterior mean of the importers’ beliefs should be sufficiently greater than the mean of the cost. By choosing $\theta_1 = 10 \cdot \sigma$, we virtually guarantee this will be the case.\footnote{Our choice of $\theta_1 = 10 \cdot \sigma$ makes the probability of not entering the market after the first entrance close, but not exactly equal, to zero.}

Since $\sigma_c^2 = \sigma_{\eta_0}^2 = \sigma^2$, and as a result the variance of the initial ex-ante cost distribution is also equal to $\sigma^2$, the choice of $\sigma$ is just a normalization. After finding the optimal $\alpha^*$’s and corresponding $\theta$’s in terms of $\sigma$, we set $\sigma$ equal to 200. Then, we calculate the exact values of $\theta_1$ and $\theta_2$. We assume the $\eta$’s are the same for the exporters and derive these from aggregate trade data. Again, this simplification does not change our results. We set $\eta$ equal to the average of
the last five data: \( \eta = \frac{\text{Avg. } y_{\text{data}} \text{ of } 00-05}{I'} \).

The above procedure gives us \( \theta_1, \theta_2, \) and \( \eta \). We use equation (14) to calculate \( \mu_{\hat{\theta}_0} \). Using this result and \( \theta_2 \), we calculate \( \mu_c \) from equation (15). Since we know both \( \mu_c \) and \( \mu_{\hat{\theta}_0} \), we can find the pairs \((f, b)\) which satisfy the equation \( \mu_c = f + b \cdot \frac{1}{\mu_{\hat{\theta}_0}} \). We set \( f \) to be 1838, and this gives a unique \( b = 153800 \). We choose \( \beta = 0.99 \). We want the model’s actual number of exporters, \( I' \), to be 9, as in the actual data. Therefore, we use a maximum likelihood method to find the optimal number of potential exporters, \( I \), most likely to endogenously generate \( I' = 9 \):

\[
L = \left( \frac{I}{9} \right) (0.3542)^{I-9} (0.6458)^9.
\] (17)

The first term denotes the choice of 9 exporters among the \( I \) potential exporters. 0.3542 is the probability of not entering the market for 45 periods. \( (I - 9) \) is the number of firms not entering the market for the entire 45 periods. 0.6458 is the probability of entering the market at some point during the 45 periods. Using this method, \( I = 13 \). Now we have all the parameters used in the Japanese simulations: \( \eta, \mu_{\hat{\theta}_0}, \sigma, \beta, \mu_c, f, b, T, I, \) and \( I' \).

Appendix C: Numerical Simulations

This section explains the details of the simulations in section 4 and presents the parameters used in each simulation. In all the simulations, there is a set of benchmark parameters with which to compare different situations. The benchmark case will be compared with overvalued beliefs (figure 10 from section 4.1), under different \( H_0 \)’s (figure 12 from section 4.2), and with trade barriers and export subsidies (figure 13 from section 4.3).

For the benchmark case, the number of time periods is set to \( T = 100 \) in order to show the potential differences in the short and long run. We set the potential number of exporters to \( I = 15 \), where the number of actual exporters is determined endogenously. We choose the discount factor \( \beta = 0.99 \). The parameters of the prior belief distribution are \( \mu_{\hat{\theta}_0} = 1000 \) and \( \sigma_{\hat{\theta}_0} = 100 \). We set the actual productivity to \( \eta = 2000 \). For simplification, all the exporters have the same actual productivity level, \( \eta \), which can be interpreted as a normalization. Note that the benchmark case corresponds to the case where importers undervalue exporters. Posterior beliefs are determined endogenously. We set the parameters for productivity shocks and cost shocks to

\[ \theta_2 = +2 \cdot \sigma \]
be the same: $\mu_\epsilon = \mu_c = 0$ and $\sigma_\epsilon = \sigma_u = 100$. As a result of this parametrization, $H = 1$ in the benchmark case, i.e. importers give equal weight to their beliefs and their experience in each period. Finally, the parameter of the cost function is set to $f = 1300$.

In the first simulation (figure 10), we compare two cases, one in which importers undervalue exporters (benchmark) and another in which importers overvalue exporters. We choose two opposite examples of importers’ beliefs in order to highlight the effect of asymmetric information and the importance of learning, reputation building, and signaling. The parameters of the benchmark case are described above. For the case when importers overvalue exporters, we just change the parameters $\mu_{\hat{\eta}_0}$ and $\eta$ and keep all the other parameters the same. We set $\mu_{\hat{\eta}_0} = 2000$ and $\eta = 1200$. We run the simulations 10000 times and present the average values of these simulations in figure 10.

In the second simulation (figure 12), we compare different $H_0$’s, fixing all the other parameters to be the same as the parameters in the benchmark case above. We let $H_0 \in [1, 45]$ to show the results under different values for $H_0$. We change the precision of the prior beliefs, $h_{\hat{\eta}_0}$, in order to get different values of $H_0$ in the simulations. Again, we run the simulations 10000 times and present the average values.

In the third simulation (figure 13), we compare the benchmark case with two other cases. The first case is the one with trade barriers, and the second case is the one with export subsidies. The benchmark case can be interpreted as free trade with no export subsidy policies. In the trade barriers case, $\psi = +50$ and all the remaining parameters are the same. Recall, $\psi = 0$ corresponds to the benchmark case. In the export subsidies case, $\psi = -50$ and, again, all the other parameters are the same as those in the benchmark case. Figure 13 shows how the extent of asymmetric information, $\kappa$, changes under different policy regimes. We take the average over $I$ exporters in a given simulation, and, then, we run the simulations 10000 times and present the average values over the simulations. Since we run the simulations 10000 times, the effects of productivity shocks are washed out of $\kappa$. 36
References


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