Shipping The Good Apples Out Under Asymmetric Information: When Weak Institutions Lead to Welfare-Diminishing Trade*

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April 12, 2013

Abstract

Institutions and product quality have each gathered considerable interest as to their effects on international trade and growth. We consider how weak home institutions can reduce the returns to high quality products, thereby creating inefficiency, and we explore whether the ability to export to markets with strong institutions can alleviate this inefficiency. We model this and find that access to a developed market can exacerbate the problems caused by weak institutions in the home market and harm home welfare further. Among other results, first, there is always an export price at which the country is better off if exporting were prevented in this market. Second, any harm is increasing in the amount exported. Third, if some high quality remains on the home market, then home welfare can always be increased by restricting exports. Fourth, the opening of trade can reduce producer surplus and so in the long run lead to a reduction in the production of the export good. Fifth, welfare can decrease even if production of the exported good increases.

Keywords: adverse selection, moral hazard, asymmetric information, quality, trade, development

JEL classification: D82, F12, L15, O24

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*We thank J. Debb, J. Ederington, M. Hummels, C.-H. Miao, M. Osborne, J. Wilson and S. Zhu for their suggestions, as well as participants at seminars at Claremont McKenna, Michigan State, Texas A&M, Southern Methodist University, University of Kentucky, University of South Carolina, the Bureau of Economic Analysis of the Dep't of Commerce, the RES Annual Conference, Midwest International Trade, and the International IO Conferences for their comments.

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1 Introduction

Recent work has shown the extent to which weak institutions can hamper economic growth (*e.g.*, Acemoglu *et al.*, 2001, Rodrik *et al.*, 2004, Acemoglu *et al.*, 2005). Among other problems, weak regulatory and judicial institutions hinder markets that are characterized by asymmetric information as sellers cannot capture their product's true value when regulatory scrutiny is scant or unreliable, or it is too costly to enforce contractual promises and warranties. Indeed, "regulatory quality" and "rule of law" are two of the six indicators used by the World Bank to appraise governance and economic development (Kaufmann *et al.*, 2009).

This problem with weak regulatory and judicial institutions in the enforcement of contracts has motivated research focusing on how the hold-up problem problem in particular can lead to the under provision of input quality (*e.g.*, Antras 2005, Acemoglu, *et al.*, 2007, Levchenko 2007, Vogel 2007, Costinot 2009). They find that it can lead to a comparative disadvantage in producing goods in the "institutionally dependent" sector, i.e., with "greater contractual incompleteness" than the developed country (Acemoglu, *et al.*, 2007, Levchenko 2007). Presumably such institutional deficiencies can also affect output markets and other aspects of transactional efficiency, such as claims to product quality –the focus of our paper– leading to again producers not capturing their product's entire value as well as introducing another inefficiency: misallocations with heterogeneous consumers. That is, the well-known problems of adverse selection and moral hazard in quality should also be more prevalent.

While not considered in the aforementioned models, exporting the imperfectly valued good offers a way to alleviate part of this inefficiency by bypassing the home market and selling the good to markets with strong institutions that allow them to credibly communicate their product's value.[1,2] Indeed, Young (1999) and Hanson and Feenstra (2004) have studied how Hong Kong and other re-exporters serve as quality verifiers. More generally, the ex-

[1]There is also a partly analogous story of financial capital outflows to bypass weak domestic institutions. Ju and Wei (2010) find that this has an ambiguous effect for the home country.

[2]Antras (2005) specifically assumes that trade cannot bypass this problem. Likewise, these models do not consider importing even though intermediate goods account for almost two-thirds of international trade (Johnson and Noguera 2012). However as the imported good is under the jurisdiction of the local institution, it faces the same problem as domestic inputs and so importing does not offer a solution in these models.

porting of high quality products is often viewed as important for economic growth and, *e.g.*, Hausmann, *et al.* (2007) find empirical support for this.[3] However, when this occurs a country may see their high quality products exported and only low quality remaining—shipping the good apples out—even when seemingly there is home demand for high quality: there are anecdotal stories of being able to buy high quality home products only while abroad. One possibility is that this is just a result of a coordination failure: if no one expects high quality on the home market, then the home price is too low and so all high quality is exported.

At the same time there has been recent empirical interest in the role of quality in international trade. In particular, Hummels and Skiba (2004) in examining the relationship between export quality across different destinations as a function of shipping costs find support for the Alchain and Allen (1964) conjecture that high quality products are exported, while low quality ones remain at home. However, these studies do not examine the role of information asymmetry in trade and in fact quality generally is not directly observed (a notable exception is Crozet, *et al.* 2012 who use wine ratings), but rather inferred from prices or a combination of prices and other variables.[4] There is also an extensive literature examining trade with asymmetric information including the seminal papers of Grossman and Horn (1988) and Bagwell (1991). The focus there, however, has been on home producers communicating their quality to the export market and welfare improving export subsidies, rather than producers using the export market to bypass home market inefficiencies.[5]

To explore these ideas, we develop a model with these characteristics: a competitive home market with asymmetric information regarding quality, and a developed foreign market in which quality is observable. Firms choose whether to enter a market, but a fraction of their resulting production is of low quality.[6] Home consumers and government are unable to

[3]For a brief review see Khandelwal (2010) or Hallak and Schott (2011).

[4]*E.g.*, Hummels and Klenow (2005) and Khandelwal (2010). See also Hallak and Schott's (2011).

[5]A partial exception is Grossman and Horn (1988) who examine the infant industry argument in a reputation model with home producers facing foreign importers of known quality. Export to a market where their quality is verifiable is not an option for the home producers.

[6]Etro (2011) examines the importance of entry in trade models with complete information.

observe quality, but a firm (and the foreign market) can observe quality and sort it.[7]

We begin with autarky as the benchmark. Firms choose not to sort their unobservable quality, putting both high and low quality together on the same market, lowering welfare through misallocation. We then consider the effect of there being an export market where quality is verifiable, considering both short run (*i.e.*, fixed supply) and long run effects.[8] Not surprisingly, some or all of the high quality product is exported—good apples are shipped out. Surprisingly, even when the export price is below the home choke price all high quality can be exported, and this is not simply a coordination failure. Rather, this occurs when the export of high quality drives down the home price as average quality at home is decreasing in exports. The lower home prices can also lead to home firms' profits decreasing when the weighted average of the export price and the home price is less than the autarkic price. However, the home price need not decrease with exports as exports also reduce output on the home market, and so it is possible that the home price equilibrates to the export price.

Turning to welfare analysis, we find that access to developed markets can harm home welfare.[9] First, there always exist export prices that induce adverse selection at home and harms welfare. That is, the country is better off if all exporting is blocked. Second, the harm is increasing in the amount of high quality exported. The main force behind this result

[7]An alternative, behavioral interpretation is that a fraction of firms have less innate ability and so must incur a small effort cost to provide high quality, or have no personal integrity and are willing to cheat on quality. This is closer in nature to the assumption in Costinot (2009), where a fraction of the contracts are enforced and non-enforcement results in zero value. This fractional assumption also appears in Acemoglu *et al.*, (2007), where a fraction of the contracts are nonverifiable and noncontractible; Levchenko (2007), where a fraction of the investment is relationship specific and unenforceable.

[8]A different interpretation of the model is the export of high quality workers: the brain drain. Talented workers may not be able to signal their quality either because verification methods are weak, or perhaps are blocked by other institutional, legal, sociological or cultural barriers. By immigrating to countries that can verify and reward quality, these workers reduce the average quality of the remaining workers. Even if signals are available (*e.g.*, standardized test scores, or acceptances to universities), they may not be viewed as verifiable at home. While a benefit of the "brain drain" is that a significant portion of the higher income is repatriated home, our results suggest that even if all of their income is repatriated welfare may be reduced. Interpreting this in terms of the effect of weak institutions on input markets which others have examined (Acemoglu, *et al.* 2007, Levchenko 2007, Nunn 2007 and Costinot 2009), trade can result in export of high quality inputs to the detriment of more complex home production that depends on higher quality inputs.

[9]Levchenko (2007) finds a similarly flavored result; namely that the country with weak institutions can lose from "institutional comparative advantage driven trade." The source of the result differs, as in Levchenko it comes from the loss of "good" jobs in the institutionally dependent sector (as wages differ across sectors), which contracts with trade.

is intuitive: home market prices are determined by the marginal consumer's valuation of quality, but the loss to home welfare from high quality being exported is the average valuation of all consumers (since which home consumer had received that high quality good is random). Third, home welfare can *always* be increased by restricting exports if in equilibrium some high quality remains on the home market. When all high quality is exported, it is still possible that welfare can be increased by restricting exports even if home country welfare is greater with exporting. Fourth, the harm to home welfare may be non-monotonic in export prices, *e.g.*, for low export prices exporting harms home welfare, for higher prices exporting increases home welfare, but for even higher prices exporting harms home welfare.

Comparing the long and short run outcomes, since producer surplus can decrease with exporting, a country with a new export market can find this export sector *shrinking* over time. In terms of welfare, while one might expect that entry decisions should mitigate any harm found in the short run, we find that welfare can be lower in the long run. The reason is that more entry results in even less high quality being sold on the home market. Thus, the range of export prices that harm home welfare can be greater in the long run. It is even possible that home welfare could increase if trade were unexpectedly blocked.

We then extend the model to allow for investment to increase the fraction of output that is of high quality (*i.e.,* a greater fraction of good apples). We find first that the possibility of export may have *no* effect on the decision to invest in quality and so the previous results still hold. This occurs when trade equilibrates the home price to the export price. As a result, all quality is sold at the same price and so firms have no reason to invest. The other possibility is that all high quality is exported. While this resolves the moral hazard issue (all firms will make the Pareto improving investment which they did not in autarky), home welfare, and even home producer surplus, can still decrease as there is less high quality on the home market.

In the next section we introduce the basic assumptions of the model where in the first stage firms make their entry decisions and in the second stage they make their exchange decisions. Section 3 characterizes the second stage, comparing what occurs with and without

trade. Section 4 characterizes the first stage and in the penultimate section firms can also invest in the first stage to increase quality. The final section concludes.

2 The Model

There is a small, developing home country and a large developed foreign market. In the home market neither consumers nor the home government can observe product quality, s. The developed foreign market has the institutions to verify a product's quality allowing home firms to receive a higher price for their high quality products through exports.

For home consumer preferences, we adopt a standard structure (Bagwell and Riordan, 1991), but allow for non-linear demand. There is a mass of consumers normalized to one, with each consumer demanding exactly one unit of the good. The quality is either high or low: $s \in \{H, L\}$. Consumers have heterogeneous reservation prices, denoted v, for a high-quality product, distributed with a strictly positive density everywhere with the support normalized to [0,1]. Let $h(q)$ be the inverse demand for high quality generated by this distribution, *i.e.*, the value v for the consumer with the q^{th} highest value, so $-\infty < h'(q) < 0$. To fix ideas we will sometimes give as an example when v is uniformly distributed so that demand is linear. There is a common reservation price for a low-quality product, for ease normalized to zero, but as will be clear from the derivations this has no qualitative effect on the result so long as consumers value high quality more. A consumer with value v for the high quality product and belief ρ that a product is of high quality, then, has an expected value of ρv.

On the production side there are two stages: in stage one firms choose whether to enter and in stage two exchange occurs. Specifically, in stage one there is a mass of potential firms that simultaneously choose whether to enter the market. Firms are heterogeneous in entry (or fixed) costs, e, distributed with a strictly positive density everywhere on $[0, 1]$. From this distribution let $e(q)$ denote the entry cost for the firm with the q^{th} lowest entry cost (so $0 < e'(q) < \infty$) with the most efficient firm's entry cost normalized to zero ($e(0) = 0$). In Section 5, firms can also invest in quality in stage one.

In stage two, each firm has a unit of output of which a percentage $\overline{\rho} \in (0,1)$ is of high quality.[10] Each firm has zero cost of production: high and low qualities have the same cost of production. While $\overline{\rho}$ is common knowledge, quality itself is unobservable. However, a firm can sort (learn) its products' quality by incurring a sorting cost $c \geq 0$, but this sorting is not observable to home consumers or government. Because of the strong institutions in the foreign market, high quality is observable there. It is assumed that home firms are price takers on the foreign market so as to abstract from the well-known market power reason (terms-of-trade effect) for export (output) restrictions which would *strengthen* our results if it were included.[11] The stage-two equilibrium can be interpreted as examining what occurs when trade becomes unexpectedly possible (or impossible) after entry decisions are made. That is, the stage-two equilibrium can be considered the short run effects of trade. As supply is fixed it is also comparable to models that assume an inelastic supply (for instance, Hummels and Skiba, 2004).

3 Exchange Equilibrium (Short Run Response)

In stage two, there is a continuum of home firms whose mass is denoted $\overline{q}$. Since there is a continuum of firms, $\overline{\rho}\,\overline{q} \equiv \overline{q}_H$ of the aggregate output is of high quality; and, $(1-\overline{\rho})\,\overline{q} \equiv \overline{q}_L$ is the low quality output, with $\overline{q}_H + \overline{q}_L \equiv \overline{q}$ so $\overline{\rho} = \frac{\overline{q}_H}{\overline{q}_H + \overline{q}_L}$.

3.1 Autarky

We take autarky as the *status quo*, *i.e.*, home firms are unable to export to the developed market. Since both types of quality have the same cost of production and quality is unobservable, all firms are willing to sell all of their output at any positive price and so consumers expect for any positive price that a product is of high quality with probability

[10] This assumption can alternatively (and commonly) be interpreted as with probability $\overline{\rho} \in (0,1)$ a given firm has high quality. As it is more natural in the context of our story, we use the first interpretation. The fraction of high quality could also be interpreted as being a group with a lower *percentage* of low quality.

[11] As a firm does not internalize its export's negative price externality on other exporters, it is optimal for the home government to restrict exports.

$\overline{\rho}$. The marginal consumer's valuation given $\overline{q}$ units of supply is $\overline{\rho}\,h(\overline{q}) + (1-\overline{\rho})0$, so the Walrasian market-clearing price in the home market (under autarky) is $P_A \equiv \overline{\rho}\,h(\overline{q}) > 0$. In equilibrium, then, all firms supply their output.

Home welfare (W), consumer welfare plus profits, in autarky (denoted by W_A) is

$$W_A(\overline{q}) = \left\{ \int_0^{\overline{q}} \overline{\rho}\,h(x)dx - \overline{q}\,\overline{\rho}\,h(\overline{q}) \right\} + \overline{q}\,\overline{\rho}\,h(\overline{q}) = \int_0^{\overline{q}_H+\overline{q}_L} \frac{\overline{q}_H}{\overline{q}_L+\overline{q}_H} h(x)dx. \tag{1}$$

It is straightforward to show this is the *second-best* welfare optimum, *i.e.*, constrained Pareto optimal where the constraint is that there is incomplete information about product quality.

Not surprisingly, the *first best* outcome is obtained with complete information as the qualities are separated. It is assumed that sorting cost c are sufficiently small so that welfare is greater with sorting. However, the home price for high quality is higher in the first best and, if $h(q)$ is not too convex in q, (*e.g.*, with linear demand), consumer welfare is lower with complete information.[12] Still, home welfare is greater because the allocative inefficiency is eliminated. That is, the high quality product is matched to those with the greater value with probability $1 > \overline{\rho}$ (the probability under incomplete information).

3.2 Exporting

Firms now can export their product at a per unit cost $t > 0$, which may include home inefficiency costs (*e.g.,* bribes), to the developed foreign market. In addition, to sell in the foreign market the home firm may have to pay verification costs at $v \geq 0$ per unit.[13]

The foreign market has a competitive price p_F for the high quality good and a price of zero for the low quality good. The price that the home firm receives for their high quality product is net of sorting, transportation and verification costs: $p_X = p_F - c - t - v$. As the issue at hand is the welfare effect of exporting, it is assumed that $p_X > P_A$, since otherwise

[12]Consumer welfare, $CW(q) \equiv \int_0^q h(x)dx - h(q)q$, is strictly convex in q (and so $\rho CW(q) > CW(\rho q)$) if $-h'(q) - h''(q)q > 0$.

[13]Since the home country's institutions are weak even if the firm incurs the sorting and verification cost at home it still cannot convince buyers that what it claims is its high quality portion is truly so. Further, this verification cost is not necessary for the results given transportation and sorting cost, but rather is included only for purposes of generality.

exporting is not attractive to firms. Since the home country is relatively poor, there is no demand for the import of the foreign good, $p_F + t > h(0)$. Alternatively, it can be assumed that since quality cannot be verified in the home country, it cannot be verified that the foreign import is actually of high quality.

Since there is zero cost of production, all the non-exported units are supplied to the home market at any positive home price.[14] Denote the amount of high (low) quality supplied on the home market as q_H ($\overline{q}_L$, since no low quality is exported), so the amount exported is $q_H^X \equiv \overline{q}_H - q_H$. The equilibrium with exporting is determined by i) the fraction of high quality output that firms choose to export and ii) home consumers' beliefs about the average quality of goods on the home market, where home consumers' beliefs as to the average quality of the products on the home market must be consistent with the actual average quality. If consumers' beliefs are consistent, then their belief of average quality (ρ) must equal the actual average quality in equilibrium, *i.e.*, given q_H and q_L units serving the home market in equilibrium, beliefs must be $\rho(q_H, q_L) \equiv q_H/(q_H + q_L)$. Then, the Walrasian price is

$$P(q_H, q_L) = \rho(q_H, q_L)h(q_H + q_L) = \rho((\overline{q}_H - q_H^X), \overline{q}_L)h((\overline{q}_H - q_H^X) + \overline{q}_L),$$

and the effect of an increase in high quality (a decrease in exports) on the home price is

$$P_1(q_H, q_L) = \rho_1(q_H, q_L)h(q_H + q_L) + \rho(q_H, q_L)h'(q_H + q_L). \tag{2}$$

For these quantities and price to be an equilibrium no firm would want to deviate from its choice as to where it supplies its high quality. Since it is assumed $p_X > P_A$, there are two possible equilibria: first, the export price is above the home price and all high quality is exported. This is an equilibrium as no firm would want to deviate to sell some of its high quality on the home market and cannot export any of its low quality. In the second possible type of equilibrium, the home price equals the export price and some high quality remains on the home market. This is an equilibrium as no firm has an incentive to deviate from where it sold its high quality: its export units receive the same price as the non-exported

[14] Implicitly we are ruling out equilibria with coordination failure. The efficiency implications of coordination failures are well understood and would only reinforce our main findings.

units. In this case, the equilibrium quantity is implied by $P(q_H, \overline{q}_L) \equiv p_X$, or

$$P(q_H, \overline{q}_L) = \rho(q_H, \overline{q}_L)h(q_H + \overline{q}_L) = \frac{q_H}{q_H + \overline{q}_L}h(q_H + \overline{q}_L) = p_X. \tag{3}$$

The second equilibrium can exist because the home price can be *increasing* in high quality exports. This is because while high quality exports lower the average quality on the home market ($\partial\rho(q_H, q_L)/\partial q_H \equiv \rho_1(q_H, q_L) = q_L/(q_H+q_L)^2 > 0$), they also reduce output on the home market, so the marginal consumer's value for high quality is increasing ($h'(q) < 0$). Since $\rho(q_H, q_L)$ and $h(q_H + \overline{q}_L)$ are continuous in q_H and $P(0, \overline{q}_L) = 0 = P(1, \overline{q}_L)$, then in such an equilibrium, there is at least one closed set of q_H in which $P(q_H, \overline{q}_L) \geq p_X$. The minimum in the set is an unstable equilibrium: an increase in exports causes the home price to decrease (and *vice versa*). The maximum, instead, is stable as an increase in exports causes the home price to increase. For this reason we will focus on the maximum, denoting it $\hat{q}_H(\overline{q})$, which, as will be shown below, is also the welfare maximizing value of the set making exporting as attractive as possible.

Returning to the first equilibrium, it can exist when $\overline{\rho}h(0) > p_X$, the home choke price is greater than the export price, without a coordination failure (*i.e.*, all consumers arbitrarily expect all high quality to be exported). First, if $P_1(q_H, \overline{q}_L) > 0$ for all $q_H \leq \overline{q}_H$, then p_X is greater than the home price for every level of export. Second, even if $P_1(\overline{q}_H, \overline{q}_L) < 0$ the equilibrium results if p_X is greater than possible home prices. Specifically, let $q_H^*(q_L)$ denote the feasible q_H (*i.e.*, $q_H \leq \overline{q}_H$) that maximizes $P(q_H, q_L)$. If $P(q_H^*(q_L), q_L) < p_X$, then even if the home price is initially increasing in exports, its maximum is still below p_X and so for all q_H the export price is greater than the home price and all high quality is exported.

3.3 The Effects of Exporting on the Home Market

Consider first consumer welfare. With $q_H < \overline{q}_H$ on the home market it is

$$CW(q_H) = \frac{q_H}{q_H + \overline{q}_L}\left[\int_0^{q_H+\overline{q}_L} h(x)dx - (q_H + \overline{q}_L)h(q_H + \overline{q}_L)\right],$$

where the first term captures gross utility and the second consumer expenditures. Differentiating with respect to high quality output (*i.e.*, the negative of a unit exported) gives

$$\frac{dCW(\overline{q}_H)}{dq_H} = \frac{\overline{q}_L}{(q_H+\overline{q}_L)^2}\left[\int_0^{q_H+\overline{q}_L} h(x)dx - (q_H+\overline{q}_L)h(q_H+\overline{q}_L)\right] - \overline{q}_H h'(q_H+\overline{q}_L) > 0.$$

Consumers, then, are harmed by exporting, even if the home price decreases. This is because a decrease in price reflects the marginal consumer's decrease in expected value, but all infra-marginal consumers have a *greater* decrease in expected value as demand slopes downward (*i.e.*, $d\rho v_1 < d\rho v_2 < 0$, if $v_1 > v_2$ and $d\rho < 0$), and so are worse off.

Turning to home welfare it is useful to express it as the sum of welfare in the home market plus the repatriated profit from exporting. Home market welfare is

$$W^H(q_H,\overline{q}_L) = \int_0^{q_H+\overline{q}_L} \frac{q_H}{q_H+\overline{q}_L} h(x)dx,$$

and so home welfare with exporting, denoted $W(q_H,\overline{q}_L)$, which includes the repatriated profit, is

$$W(q_H,\overline{q}_L) = W^H(q_H,\overline{q}_L) + p_X(\overline{q}_H - q_H).$$

The effect of a high quality unit being exported on the home market welfare is

$$\frac{\partial W^H}{\partial q_H^X} = -\frac{\partial W^H(q_H,\overline{q}_L)}{\partial q_H} = -\left[\frac{q_H}{q_H+\overline{q}_L}h(q_H+\overline{q}_L) + \int_0^{q_H+\overline{q}_L} \frac{\overline{q}_L}{(q_H+\overline{q}_L)^2}h(x)dx\right] < 0. \quad (4)$$

The first term inside the brackets is the benefit of a unit of average quality being supplied to the home market (the price) and the second is the benefit from average quality increasing in the home market: a high quality unit being exported harms home market welfare. However, there is a benefit to home welfare from a unit being exported: the increase in export profits, p_X. Summing the two yields the effect of a unit being exported at autarky ($q_H = \overline{q}_H$):

$$\begin{aligned}\left.\frac{\partial W}{\partial q_H^X}\right|_{q_H=\overline{q}_H} &= -\left[\frac{q_H}{q_H+\overline{q}_L}h(q_H+\overline{q}_L) + \int_0^{q_H+\overline{q}_L} \frac{\overline{q}_L}{(q_H+\overline{q}_L)^2}h(x)dx\right]_{q_H=\overline{q}_H} + p_X \\ &= -\overline{\rho}\,h(\overline{q}) - \frac{\overline{q}_L}{(\overline{q}_H+\overline{q}_L)^2}\int_0^{\overline{q}} h(x)dx + p_X.\end{aligned}$$

Thus, at autarky, a high quality unit exported reduces home welfare if and only if

$$p_X < \overline{\rho}\, h(\overline{q}) + \frac{\overline{q}_L}{(\overline{q}_H + \overline{q}_L)^2} \int_0^{\overline{q}} h(x)dx = \overline{\rho}\, h(\overline{q}) + (1-\overline{\rho}) \int_0^{\overline{q}} h(x)dx/\overline{q}. \tag{5}$$

As the first term on the RHS of the inequality is the autarkic market price and the second term is strictly positive, there always exist export prices such that the home welfare is harmed by the first unit exported if $\overline{\rho} < 1$.

At first glance it appears as if nothing is wrong (and actually better) with the exporting: high quality is exported to a wealthier market for a higher price and low quality is sold at cost in the home market; good apples are exported, bad ones stay home. However, welfare has been lowered even though the markets are segmented, which normally would increase welfare. The intuition for why is straightforward. When a unit of high quality is exported, the marginal consumer no longer buys. The probability the high quality unit went to the marginal consumer is $\overline{\rho}$ and so that consumer's valuation was $\overline{\rho}h(q)$, *i.e.*, the market price (the first term on the RHS). However, with probability $(1-\overline{\rho})$ that high quality unit would have been randomly bought by some other consumer and so there is a second loss: the average value of high quality to all consumers who are purchasing weighted by the probability of one of them receiving it (the second term), all of whom have a higher value than the marginal consumer (the home price) since demand slopes downward.[15]

Consider next the effect of additional units being exported. Welfare is concave in q_H:

$$\begin{aligned}\frac{\partial^2 W(q_H, \overline{q}_L)}{(\partial q_H)^2} &= \frac{q_H}{q_H + \overline{q}_L} h'(q_H + \overline{q}_L) - \frac{2\overline{q}_L}{(q_H + \overline{q}_L)^3} \int_0^{q_H + \overline{q}_L} h(x)dx + \frac{2\overline{q}_L}{(q_H + \overline{q}_L)^2} h(q_H + \overline{q}_L) \\ &= \frac{q_H}{q_H + \overline{q}_L} h'(q_H + \overline{q}_L) - \frac{2\overline{q}_L}{(q_H + \overline{q}_L)^2} \left[\int_0^{q_H + \overline{q}_L} \frac{h(x)}{q_H + \overline{q}_L} dx - h(q_H + \overline{q}_L) \right] < 0.\end{aligned}$$

The inequality is an implication of downward sloping demand, $h'(\cdot) < 0$: the first term is negative and the bracketed term is positive because the average value of high quality, $\int_0^q h(x)dx/q$, is greater than the marginal consumer's value, $h(q)$. Thus, when (5) is true the harm to the home market from a unit exported is *increasing* in the amount of exports.

[15] This intuition is related to Spence's regarding *monopoly* quality choice under *certainty* (1975, 1976).

There are two reasons why the harm is increasing in exports. First, fewer units bought in the home market means that the marginal consumer no longer buys so the average value for a given level of quality increases and hence the loss of another unit exported is greater. Second, average quality is decreasing at an increasing rate. Thus, the condition (5) for home welfare to decrease from exports at autarky implies that home welfare decreases from a firm choosing to export independent of the amount of high quality exported. To summarize,

Proposition 1 *In stage two if* $p_X < \overline{\rho}\, h(\overline{q}) + (1-\overline{\rho}) \int_0^{\overline{q}} h(x)dx/\overline{q}$*, then home welfare is harmed by exports. Such a* p_X *always exists if* $\overline{\rho} \in (0,1)$*.*

As the harm to home welfare is increasing in exports while the benefit (p_X) is constant, then even if the first unit exported increases home welfare, home welfare may decrease from exporting. To put it differently, the harm from the marginal export when all is exported is greater than the harm from the first one. Thus, there is a weaker condition than (5) for exporting to harm home welfare: if the sum of benefits is less than the sum of harm, or in terms of the export price:

$$W(q_H, \overline{q}_L) < W_A(\overline{q}) \Longleftrightarrow p_X < \frac{\overline{\rho} \int_{q_H+\overline{q}_L}^{\overline{q}} h(x)dx + \left(\overline{\rho} - \frac{q_H}{q_H+\overline{q}_L}\right) \int_0^{q_H+\overline{q}_L} h(x)dx}{\overline{q}_H - q_H}.$$

Note that in the limit as $q_H \to \overline{q}_H$ one obtains the condition in Proposition 1. To summarize,

Proposition 2 *In stage two, for a given level of high quality exports* $q_H^X = \overline{q}_H - q_H$*, home welfare decreases with exporting when the export price* p_X *is less than the average home value:*

$$p_X < \left[\overline{\rho} \int_{q_H+\overline{q}_L}^{\overline{q}} h(x)dx + \left(\overline{\rho} - \frac{q_H}{q_H+\overline{q}_L}\right) \int_0^{q_H+\overline{q}_L} h(x)dx\right] / (\overline{q}_H - q_H). \tag{6}$$

Further, $\left[\overline{\rho} \int_{q_H+\overline{q}_L}^{\overline{q}} h(x)dx + \left(\overline{\rho} - \frac{q_H}{q_H+\overline{q}_L}\right) \int_0^{q_H+\overline{q}_L} h(x)dx\right] / (\overline{q}_H - q_H)$ *is increasing in exports.*

Thus, the maximum export price such that home welfare decreases with exporting (the LHS of 6), is increasing in exports. The case of linear demand suggests that the range of prices under which the propositions hold need not be trivial.

Linear Demand. With linear demand ($h(q) = 1 - q$), $P_A = \overline{\rho}(1 - \overline{q}), W_A(\overline{q}) = \overline{\rho}(\overline{q} - \overline{q}^2/2)$, and the condition for exporting to harm home welfare (5) simplifies to

$$p_X < \overline{\rho}(1 - \overline{q}) + (1 - \overline{\rho})(1 - \overline{q}/2) = P_A + (1 - \overline{\rho})(1 - \overline{q}/2).$$

If $\overline{\rho} = 1/2 = \overline{q}$ then $P_A = 4/16$ and for any $p_X < 10/16$ exporting reduces welfare:

$$W(q_H, \overline{q}_L) = p_X(\overline{q}_H - q_H) + \frac{q_H}{q_H + \overline{q}_L}\left(q_H + \overline{q}_L - \frac{(q_H + \overline{q}_L)^2}{2}\right). \tag{7}$$

The condition for home welfare to be harmed (Proposition 2) at q_H is

$$p_X < 1 - (\overline{q}_H + q_H + \overline{q}_L)/2. \tag{8}$$

If all high quality is exported ($q_H = 0$), any $p_X < 12/16 = 3P_A$ reduces welfare. Note that the home market choke price is $\overline{\rho} = 8/16 < 12/16$. If $p_X = 11/16$ the first unit exported increased welfare. □

Even if home welfare increases at q_H (6 is false), the marginal export may have harmed home welfare. Begin with the case when some high quality is on the home market ($q_H > 0$) so that the home price equals the export price. From (4) the harm from the unit exported is

$$\frac{\partial W^H(q_H, \overline{q}_L)}{\partial q_H} = \frac{q_H}{q_H + \overline{q}_L}h(q_H + \overline{q}_L) + \int_0^{q_H + \overline{q}_L} \frac{\overline{q}_L}{(q_H + \overline{q}_L)^2}h(x)dx > \frac{q_H}{q_H + \overline{q}_L}h(q_H + \overline{q}_L) = p_X.$$

As the harm is greater than the benefit to home welfare (the export price), then so long as $q_H > 0$ in equilibrium, home welfare *always* increases with a small restriction on exports. In the case when all units are exported, from (4) we have the condition for the marginal exporter to harm welfare, which is weaker than the condition for exporting to harm welfare when all high quality is exported: $\int_0^{\overline{q}_L} h(x)dx/\overline{q}_L > \int_0^{\overline{q}} h(x)dx/\overline{q}$. Summarizing we have,

Proposition 3 *In stage two, home welfare is harmed by the marginal export if in equilibrium*

1. *there is high quality on the home market (*i.e., $q_H > 0$*) or*

2. *all high quality is exported and* $p_X < \int_0^{\overline{q}_L} h(x)dx/\overline{q}_L$.

The intuition for this result goes back to the central effect: an additional high quality unit raises every consumer's expected value *more* than the marginal consumer's expected value, but the market price reflects the marginal consumer's expected value.

Linear Demand. If there is high quality on the home market q_H must satisfy (3):

$$\frac{q_H}{q_H + \overline{q}_L}\left(1 - (q_H + \overline{q}_L)\right) = p_X.$$

Then the stable $\hat{q}_H(\overline{q})$ is

$$\hat{q}_H(\overline{q}) = \frac{1}{2}\left[1 - \overline{q}_L - p_X + \sqrt{1 - 2\overline{q}_L - 2p_X + (\overline{q}_L - p_X)^2}\right]. \tag{9}$$

Let $\overline{\rho} = .9$ and $\overline{q} = .9$ so $P_A = .09$. From (7), if $p_X \in (.22,.49)$, then exporting increases home welfare: $W(\hat{q}_H(\overline{q}), \overline{q}_L) > W_A(\overline{q})$. Though exporting welfare reaches a maximum at $p_X \approx .47$, the marginal export harms home welfare: $-(1 - q_H - \frac{\overline{q}_L}{2}) + p_X \approx -.66 + .47 < 0$. For when all high quality is exported let $\overline{\rho} = .95$ ($P_A = .095$). From (9), if $p_X > .62$, all high quality is exported. The cost of the marginal export is $1 - \frac{\overline{q}_L}{2} = .9975$. Thus, for $p_X < 10P_A$ the marginal export harms home welfare. □

Home producer surplus can also decrease when all high quality is exported if the export price is sufficiently close to the autarkic price. This is because with exporting only $\overline{\rho}\,\overline{q}$ output sells at p_X, while the remaining low quality sells at cost. Specifically,

Proposition 4 *If the export price is less than the marginal consumer's value for high quality,* i.e.*, $p_X < h(\overline{q})$, then producer surplus decreases in stage two when all high quality is exported. Such an export price greater than the autarkic price ($\overline{\rho}\,h(\overline{q})$) always exists.*

Proof. $p_X \overline{\rho}\,\overline{q} < P_A \overline{q} = \overline{\rho}\,h(\overline{q})\overline{q} \leftrightarrow p_X < h(\overline{q})$. Existence follows as $P_A = \overline{\rho}\,h(\overline{q}) < h(\overline{q})$. ■

Linear Demand. The condition becomes $p_X \overline{\rho}\,\overline{q} \leq \overline{\rho}(1 - \overline{q})\overline{q}$: $p_X < 1 - \overline{q}$. For example, if $\overline{\rho} = 3/5$ and $\overline{q} = 3/8$, then $P_A = 3/8$ and for $p_X < 5/8$ producer surplus decreases. □

3.3.1 Effect of exporting on the home price

In this section we further characterize the effect of exporting on the home price. First, for small q_H the home price is increasing in q_H and for large q_H it is decreasing. To see

this, note that starting from no high quality ($q_H = 0$) and $q_L \in (0,1)$, the home market price is increasing in q_H since positive value is being added: from (2) $P_1(0, q_L) > 0$ since $\rho_1 > 0$ and $h(q_L) > 0$. However, this effect is decreasing in high quality ($\rho_{11} < 0$) and for large enough q_H the price decreases in q_H: as either $h(q) \to 0$, or $\rho_1 \to 0$, we have $P_1(q_H, q_L) < 0$. Indeed, for common specifications of demand $h(q)$, *e.g.*, linear or constant elasticity of demand, $P(q_H, q_L)$ is *strictly unimodal* (single peaked) in q_H: the home market price is first strictly increasing and then decreasing in q_H and high quality demand need not be concave.[16] Actually, for unimodality not to hold would require near horizontal or vertical segments in high quality demand.[17] For ease we will assume unimodality for the remainder although extending the analysis without unimodality is straightforward though tedious.

If the home demand is unimodal in high quality, then it follows from the earlier discussion that in equilibrium all high quality is exported if at auatarky either the home price is decreasing in high quality exports (*i.e.*, $P_1(\overline{q}_H, \overline{q}_L) > 0$), or if not, the maximum home price in exports is less than the export price (*i.e.*, $P_1(\overline{q}_H, \overline{q}_L) < 0$ and $P(q_H^*(q_L), q_L) < p_X$).

If instead $P_1(\overline{q}_H, \overline{q}_L) < 0$ and $P(q_H^*(q_L), q_L) > p_X$, then with unimodal demand there exist q_H such that the home price equals the export price and moreover there is only one pair of q_H that satisfy (3). Further, from (3) the amount of high quality on the home market $\hat{q}_H(\overline{q})$ is decreasing in the export price:

$$\frac{\partial \hat{q}_H}{\partial p_X} = \frac{-1}{-P_1(\hat{q}_H, (1-\overline{\rho})q)} < 0,$$

as $P_1(\hat{q}_H, \overline{q}_L) < 0$. That is, since the home price is increasing in exports, when the export price increases the only way to maintain (3) is to have more high quality exported.

Consider next the range of export prices that harm home welfare. Surprisingly, an increase in the export price need not increase welfare: while a higher export price increases exporters' profit it also increases exports, which increases the harm to the home market. To

[16] A function $h(x)$ is a strictly unimodal function if for some value m, it is strictly increasing for $x \leq m$ and strictly decreasing for $x \geq m$. Though similar, this concept is distinct to the strict definition of unimodal for distributions, which admits multiple local maxima although those are usually referred to as being multimodal.

[17] Strict unimodality is a weaker condition than the standard assumption of strategic substitutability as the latter implies that, with constant elasticity demand for high quality, high quality demand $h(q)$ must be inelastic while with unimodality it can be elastic. With unimodality there can be strictly convex segments.

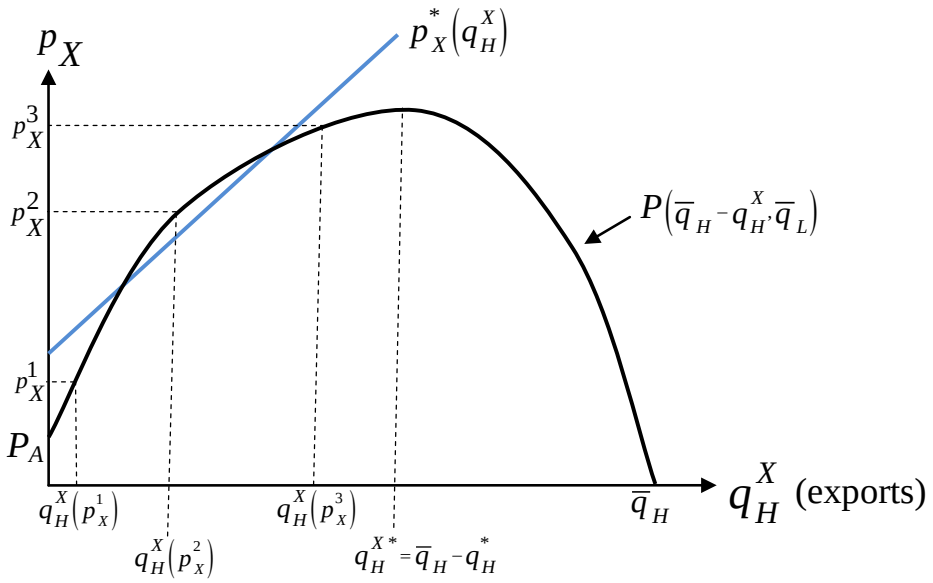

Figure 1: Non-Monotonicity in Export Price

see this, consider Figure 1. The home price as a function of exports is plotted $P(\overline{q}_H - q_H^X, \overline{q}_L)$ for when demand is unimodal, showing the exports needed to equilibrate prices. For example, an export price p_X^1, induces exports $q_H^X(p_X^1)$ to equilibrate prices. Higher prices induce more exports. However, the harm to the home market from exports is increasing in exports which is captured by the graph $p_X^*(q_H^X)$, defined by the RHS of (6), which shows the minimum export price needed for home welfare to increase for a given a level of exports. That is, for any amount exported q_H^X, welfare decreases when the export price $p_X < p_X^*(q_H^X)$. As the RHS of (6) is increasing in exports so is $p_X^*(q_H^X)$. In Figure 1, for low export prices (*e.g.*, p_X^1), exporting $q_H^X(p_X^1)$ harms home welfare as $P_X^*(q_H^X(p_X^1)) > p_X^1$; for higher export prices exporting increases home welfare (*e.g.*, p_X^2); for even higher export prices it harms home welfare again (p_X^3); and for yet even higher export prices it increases home welfare.

Linear Demand Using $\hat{q}_H(\overline{q})$ from (9), so that the home price equals the export price, welfare (7) at $\hat{q}_H(\overline{q})$ as a function of p_X is:

$$W(p_X) = p_X\left[\overline{q}_H - \tfrac{1}{2}\left[1 - \overline{q}_L - p_X + \left(1 - 2\overline{q}_L - 2p_X + (\overline{q}_L - p_X)^2\right)^{\frac{1}{2}}\right]\right] + \frac{\left[3 - \overline{q}_L + p_X - \left(1 - 2\overline{q}_L - 2p_X + (\overline{q}_L - p_X)^2\right)^{\frac{1}{2}}\right]\left[1 - \overline{q}_L - p_X + \left(1 - 2\overline{q}_L - 2p_X + (\overline{q}_L - p_X)^2\right)^{\frac{1}{2}}\right]}{8}.$$

Let $\overline{\rho} = .9$ and $\overline{q} = .9$ (so $P_A = .09$). For $p_X \in (.09, .22), W(p_X) < W_A(\overline{q})$: exporting harms welfare. For $p_X \in (.22, .49)$, exporting increases welfare. But, for $p_X \in (.49, .55)$,

all high quality is exported and exporting harms welfare. For higher export prices, exporting increases welfare. To summarize

Remark 1 *In stage two, the set of export prices that reduce home welfare need not be convex, e.g., for low export prices exporting harms home welfare, for intermediate prices exporting increases home welfare, but for higher prices exporting harms home welfare, etc.*

4 Entry Equilibrium (Long Run Response)

We now move to stage one of the game where firms make their entry decisions, which can be interpreted as the long run effect.[18] Stage-one equilibria depend on whether the firms expect autarky or trade in stage two. From the previous section, the price in stage two with autarky given q firms is $\overline{\rho}h(q)$. If the firms expect this stage-two equilibrium, in stage one firms enter until the cost of entry equals the autarkic price so the entry equilibrium denoted q_A is defined by $\overline{\rho}h(q_A) = e(q_A)$. This is the two-stage *autarky* equilibrium and $P_A = \overline{\rho}h(q_A)$, the autarkic equilibrium price. Welfare in autarky then is consumer benefit less entry costs:

$$W_A(q_A) = \int_0^{q_A} \overline{\rho}h(x)dx - \int_0^{q_A} e(x)dx. \tag{10}$$

It is straightforward to show that given autarky this is the second best welfare optimum: a social welfare maximizer that cannot observe quality would choose the same level of entry.

Linear Demand and Cost. Demand is as before and now firm q has cost $e(q) = \overline{c}q$ if it enters. With autarky expected in stage two, the entry equilibrium q_A is defined by $\overline{\rho}(1 - q_A) - \overline{c}\,q_A = 0$, *i.e.*, $q_A = \overline{\rho}/(\overline{\rho} + \overline{c})$ and so the autarky price is $P_A = \overline{\rho}\,\overline{c}/(\overline{\rho} + \overline{c})$. Welfare, which now includes entry cost, then is $W_A(q_A) = \overline{\rho}^2/2(\overline{\rho} + \overline{c})$. □

4.1 Trade Equilibrium

Recall that when firms can export their high quality goods, there are two possible stage-two equilibria. The first has all high quality exported and all low quality remaining at home at

[18] Creane and Jeitschko (2012) consider an autarkic model of entry but with firms that are *ex ante* identical, but *ex post* differentiated in cost and quality.

a price $P = 0$. At entry level q this is the unique equilibrium if demand is unimodal and either the home price is increasing in high quality, $P_1(q_H, q_L) > 0$, or, the maximum home price is less than the export price, $P_1(q_H, q_L) \leq 0$ and $P(q_H^*(q_L), q_L) < p_X$. If firms expect this in stage one, then firms enter until the marginal firm's profit from exporting $\overline{\rho}$ of their output equals its entry cost:

$$\overline{\rho} p_X = e(q_X). \tag{11}$$

The two-stage equilibrium then has the number of firms entering in stage one defined by (11), and in stage two all high quality being exported. From (11), the entry level q_X is increasing in the export price p_X.

The equilibrium level of entry when all high quality is exported may be less than that with autarky. Specifically, if $\overline{\rho} p_X < \overline{\rho} h(q_A) = P_A$, then $q_X < q_A$ and producer surplus is lower in the trade equilibrium than in the autarky equilibrium as each firm earns higher profit with autarky.

The other (potential) stage-two equilibrium has some high quality on the home market. For this to be an equilibrium the home price in the stage-two equilibrium must equal p_X and all output is sold at this price. If in stage one firms expect this stage-two equilibrium, then the marginal entrant is the firm whose entry cost equals the export price:

$$p_X = e(q_X). \tag{12}$$

The two-stage equilibrium in this case then has number of firms entering in stage one defined by (12), in stage two high quality is sold on the home market, and the home price is p_X. From (12), the entry level is increasing in the export price p_X. Since $p_X > P_A$, $q_X > q_A$.

For such an equilibrium to exist with unimodal demand requires that the maximum home price with this entry level $P(q_H^*(q_L^X), q_L^X)$ is greater than the export price and that $q_H^*(q_L^X)$ is feasible (*i.e.*, $q_H^*(q_L^X) < \overline{q}_H$):

$$P(q_H^*(q_L^X), q_L^X) \geq p_X, \tag{13}$$

$$P_1(q_H, q_L) < 0. \tag{14}$$

Recall that the stable equilibrium level of high quality on the home market that equates the home price to the export price. was denoted $\hat{q}_H$. Using (3) we have from the implicit function theorem that as entry (q) increases, $\hat{q}_H(q)$ decreases

$$\frac{\partial \hat{q}_H}{\partial q} = \frac{-P_2(\hat{q}_H, (1-\overline{\rho})q)(1-\overline{\rho})}{P_1(\hat{q}_H, (1-\overline{\rho})q)} < 0.$$

This follows since $P_1(\hat{q}_H, q_L) < 0$ and $P_2 < 0$ (increasing low quality always reduces the price as it increases aggregate quantity and lowers average quality). In other words, as there is more entry, the amount of high quality on the home market needed to equate the home price to the export price decreases. This is intuitive: more entry means more low quality on the home market and the only way to maintain the export price is by reducing output (*i.e.*, high quality) on the home market as $P_1 < 0$. Note that average quality is lower as a result. Finally, using (12) and (3) we have from the implicit function theorem that as the export price increases, the amount of high quality on the home market *decreases*:

$$\frac{\partial \hat{q}_H}{\partial p_X} = \frac{-[1 - P_2(\hat{q}_H, (1-\overline{\rho})q_X(p_X))(1-\overline{\rho})q_X'(p_X)]}{P_1(\hat{q}_H, (1-\overline{\rho})q_X(p_X))} \leq 0$$

This implies that as the export price increases, exports increase (since entry increases).

Linear Demand and Cost. If all high quality is exported in stage two, then from (11) $q_X = p_X\overline{\rho}/\overline{c}$ firms enter. If some high quality remains on the home market, then from (12) $q_X = p_X/\overline{c}$ firms enter. This requires that the maximum home price is greater than the export price (13), $P(q_H^*(q_L^X), q_L^X) = \left(1 - \sqrt{(1-\overline{\rho})p_X/\overline{c}}\right)^2 \geq p_X$ and that it is feasible (14), $P_1(q_H^X, q_L^X) = (1-\rho)\overline{c}/p_X - 1 < 0$. From (3), $\hat{q}_H$ is defined by

$$p_X = \frac{\hat{q}_H}{\hat{q}_H + (1-\overline{\rho})p_X/\overline{c}}(1 - \hat{q}_H - (1-\overline{\rho})P_X/\overline{c}). \tag{15}$$

We close this section with a comparative static for use in later analysis: as entry increases, the maximum home price (as a function of feasible q_H) is decreasing. Let $P^F(q)$ denote the maximum feasible home price given entry level q: $P^F(q) = P(\min\{q_H^*(q_L), q_H\}, q_L)$.

Lemma 1 *The maximum* ***feasible*** *home price $P^F(q)$ is decreasing in entry q.*

The proof and all remaining proofs are in the appendix.

4.2 Welfare

To begin, as home production with trade (q_X) now depends on the export price, Propositions 1, 3, and 4 do not directly hold. However, if the condition in Proposition 2 holds at q_X (*i.e.*, the export price is less than the average home value), then unexpectedly imposing autarky in stage 2 would increase welfare. Further, since q_X is not the welfare optimal level of entry when autarky is expected (q_A is), then welfare is lower with trade than autarky in the two-stage game when the conditions in Proposition 2 hold at q_X (the complete proof is in the appendix):

Proposition 5 *In the two-stage game, welfare is greater with autarky than with trade when the condition in Proposition 2 holds for q_X.*

Even if the condition in Proposition 2 is not met at q_X (*i.e.*, welfare with trade at entry level q_X, denoted $W_T(q_X)$, is greater than autarky at entry level q_X, $W_A(q_X)$), welfare could still be greater with autarky than with trade. Example 1 below shows that this is easily possible.

Next consider whether there always exist export prices such that welfare is greater with autarky in the two-stage game. Beginning with when all high quality is exported (q_X is defined by 11) home welfare is

$$W_T(p_X) = p_X\overline{\rho}q_X(p_X) - \int_0^{q_X(p_X)} e(x)dx. \tag{16}$$

Welfare with autarky, (10), less welfare with all exporting, (16), is

$$W_A(q_A) - W_T(p_X) = \int_0^{q_A} \overline{\rho}h(x)dx - \int_0^{q_A} e(x)dx - p_X\overline{\rho}q_X(\overline{\rho}p_X) + \int_0^{q_X(p_X)} e(x)dx. \tag{17}$$

This simplifies to

$$W_A(q_A) - W_T(p_X) = \int_0^{q_A} \overline{\rho}h(x)dx - p_X\overline{\rho}q_X(p_X) + \int_{q_A}^{q_X(p_X)} e(x)dx.$$

Note that if $p_X = P_A/\overline{\rho} > P_A$ (so $q_X = q_A$), then $W_A(q_A) - W_T(p_X)$ is positive:

$$W_A(q_A) - W_T(p_X) = \int_0^{q_A} \overline{\rho}h(x)dx - p_X\overline{\rho}q_X(P_A) > \int_0^{q_A} \overline{\rho}h(x)dx - P_Aq_X(P_A) > 0,$$

where the second inequality follows from $P_A = \overline{\rho} h(q_A)$. Since welfare with trade when all high quality is exported $W_T(p_X)$ is increasing in p_X, it follows that for any $p_X \in [P_A, P_A/\overline{\rho}]$ welfare is greater with autarky in the two-stage game. By a similar logic, producer surplus is also greater with autarky. Thus, with entry there is the same result as in Proposition 4 (the proof is in the appendix):

Lemma 2 *There exist export prices such that home producer surplus (hence, welfare) when all high quality is exported is lower than producer surplus with autarky.*

The following examples show that trade can harm welfare even though: 1) p_X is non-trivially greater than $P_A/\overline{\rho}$; 2) the condition in Proposition 5 does not hold; and 3) entry (home production) *increases*.

Linear Demand and Cost.[19] As $q_X = p_X\overline{\rho}/\overline{c}$ it is straightforward to derive welfare with trade $W_T(q_X) = \frac{p_X^2\overline{\rho}^2}{2\overline{c}}$. For when q_X firms enter, but there is autarky, since $q_X = p_X\overline{\rho}/\overline{c}$ firms entered, welfare is $W_A(q_X) = \frac{p_X\overline{\rho}^2(2\overline{c}-p_X(\overline{c}+\overline{\rho})}{2\overline{c}^2}$. In all of these examples $W_T(q_X) > W_A(q_X)$ and yet $W_T(q_X) < W_A(q_A)$ where $q_A = \overline{\rho}/(\overline{\rho}+\overline{c})$.[20]

Example 1

$\overline{\rho}$	$\overline{c}$	p_X	q_X	P_A	q_A	$W_T(q_X)$	$W_A(q_X)$	$W_A(q_A)$	$P_A/\overline{\rho}$
0.9	2	0.82	.369	.621	.31	.136	.135	.139	.69
0.8	2	0.84	.336	.571	.286	.113	.111	.114	.714
0.7	2	0.86	.301	.519	.259	.090	.088	.091	.741
0.6	2	0.87	.261	.462	.231	.0681	.0680	.0692	.769
0.5	2	0.89	.223	.4	.2	.0495	.0494	.05	.8

Further, for *lower* export prices p_X, welfare is *greater* when exporting is unexpectedly blocked: $W_T(q_X) < W_A(q_X)$ and so by Proposition 5 $W_T(q_X) < W_A(q_A)$.

[19] In these examples, all high quality being exported is the unique equilibrium.

[20] While there is a range of p_X such that $W_T(q_X) > W_A(q_X)$, for space consideration only a specific value is reported in the table.

Turning to when some high quality is sold on the home market ($\hat{q}_H$) so entry is defined by (12), welfare is exporters' profit, home consumer welfare and entry cost:

$$\begin{aligned} W_T(p_X) = {} & p_X\left[\overline{\rho}q_X(p_X) - \hat{q}_H(q_X(p_X))\right] \\ & + \int_0^{\hat{q}_H(q_X(p_X))+(1-\overline{\rho})q_X(p_X)} \frac{\hat{q}_H(q_X(p_X))}{\hat{q}_H(q_X(p_X)) + (1-\overline{\rho})q_X(p_X)} h(x)dx \\ & - \int_0^{q_X(p_X)} e(x)dx. \end{aligned} \tag{18}$$

Differentiating $W_T(p_X)$ (with arguments suppressed for ease of reading) obtains

$$\begin{aligned} W_T'(p_X) = {} & [\overline{\rho}q_X - \hat{q}_H] + p_X[\overline{\rho}q_X' - \hat{q}_H'q_X'] \\ & + [\hat{q}_H' + (1-\overline{\rho})]q_X' \frac{\hat{q}_H}{\hat{q}_H + (1-\overline{\rho})q_X} h(\hat{q}_H + (1-\overline{\rho})q_X) \\ & + \int_0^{\hat{q}_H+(1-\overline{\rho})q_X} \frac{(1-\rho)(\hat{q}_H'q_X'q_X - q_X'\hat{q}_H)}{(\hat{q}_H + (1-\rho)q_X)^2} h(x)dx - q_X'e(q_X). \end{aligned} \tag{19}$$

The integrand is negative (average quality on the home market decreases) as is the change in output on the home market, $[\hat{q}_H' + (1-\overline{\rho})]$, which is necessary for the home price to increase given that there is more low quality (as $q_X' > 0$). With this we can obtain (see the appendix)

Lemma 3 *There exist export prices such that when in equilibrium there is high quality on the home market, welfare is lower than it is with autarky.*

The intuition for this is as in stage two: at a price just above the autarky price home welfare loses the average consumers' value for that high quality, which is above the autarkic price. The following examples show that in this case too welfare can decrease from trade even though the condition in Proposition 5 does not hold or entry (home production) *increases*.

Linear Demand and Cost. From (12), the entry level is $q_X = p_X/\overline{c}$. For this equilibrium, conditions (13), (14) and (15) must hold. Welfare then is $W_T(q_X)$:

$$p_X(\overline{\rho}p_X/\overline{c} - \hat{q}_H) + \int_0^{(1-\overline{\rho})p_X/\overline{c}+\hat{q}_H} \frac{\hat{q}_H}{(1-\overline{\rho})p_X/\overline{c} + \hat{q}_H}(1-x)dx - \int_0^{p_x/\overline{c}} \overline{c}x dx.$$

With no trade ($q_X = p_X/\overline{c}$ entering) welfare is $W_A(q_X) = p_X(2\overline{c}\,\overline{\rho} - p_X(\overline{c}+\overline{\rho}))/2\overline{c}^2$.

To have high quality on the home market in equilibrium requires an export price lower than in Example 1. However, with a lower export price it is difficult to obtain an

example with trade welfare *greater* than autarky welfare at q_X ($W_T(q_X) > W_A(q_X)$), as it requires lower costs and large $\overline{\rho}$. (Otherwise, welfare is greater with autarkic entry by Proposition 5: $W_A(q_X) > W_T(q_X) \Rightarrow W_A(q_A) > W_T(q_X)$).

Example 2

$\overline{\rho}$	$\overline{c}$	p_X	q_X	P_A	q_A	$W_T(q_X)$	$W_A(q_X)$	$W_A(q_A)$
0.9	.2	0.2	1	.164	.818	.356	.35	.368
0.8	.2	0.23	1.15	.16	.8	.264	.259	.32

Combining Lemmas 2 and 3 we have a two-stage version of Proposition 1:

Proposition 6 *In the two-stage game (long run), there exist export prices such that welfare is lower with trade than with autarky.*

We can also use (10) and (18), to obtain the two-stage version of Proposition 2 although it is not very insightful.

There is also a two-stage version of Proposition 3: the marginal entrant reduces home welfare. However, this only can occur when some high quality remains on the home market: even though welfare can be lower when all is exported, the marginal entrant does not reduce welfare as its cost just equals the benefit (p_X). We obtain (see the appendix):

Proposition 7 *In the two-stage game (long run), home welfare is harmed by the marginal entrant if in equilibrium there is high quality on the home market.*

Finally, an *increase* in the export price can reduce home welfare. This can occur when some high quality remains on the home market. Denote the maximum export price such that there is high quality on the home market as $\hat{p}_X$. A slightly higher export price results in a discrete decrease in high quality at home and in producer surplus, reducing welfare:

Proposition 8 *When in equilibrium there is high quality on the home market, home welfare decreases in the export price at $\hat{p}_X$.*

Since we know that when in equilibrium there is high quality on the home market there always exist export prices sufficiently close to the autarkic price that harm welfare (Lemma 3), then Proposition 8 implies that, as in the short run (Remark 1), it is possible that the effect of exporting on home welfare is non-monotonic in export prices.

4.3 Short Run Versus Long Run Effects of Trade

We now compare the short run and long run welfare effects of exporting. Normally, with a shock in policy (here, trade unexpectedly becoming possible after entry decisions were made), welfare should always increase in the long run as firms adjust their entry decisions. However, here welfare can be lower in the long run. To show this we extend our model so that the two-stage game of the model is repeated (denoting each run of the two-stage game a "Period") and that the entry cost is actually a sunk cost for each Period. That is, in Period 1 the two-stage game is played: entry (incur sunk cost for Period 1), then exchange; then in Period 2 it is played again. Entry decisions in Period 1 are made with autarky as the status quo. After the entry decisions, a shock results in a change in policy allowing export, the short run effect. In Period 2, the entry decision accounts for trade, the long run effect.

We begin the analysis for when the type of stage-two equilibrium is the same whether or not trade was expected. First we establish that the stage-two equilibrium can be the same.

Lemma 4 *If all high quality exported is the unique short run trade equilibrium when autarky is expected, then all high quality exported is the unique long run trade equilibrium. If there is a long run trade equilibrium with high quality on the home market, then there is a short run trade equilibrium when autarky is expected with high quality on the home market.*

We begin with when all high quality is exported in both periods. In this case welfare always increases from Period 1 to Period 2 (although autarkic welfare may be greater than trade welfare). This is because with all high quality exported, welfare is producer surplus. As there is no externality in the entry decision in this case, the long run entry level results in greater producer surplus than in the short run. That is, producer surplus, $\overline{\rho} p_X q - \int_0^q e(x)dx$,

is maximized at $\overline{\rho}p_X = e(q)$, which of course is the entry level with trade (11). Thus, if allowing exporting increases welfare in the short run, then it increases welfare in the long run. However, if $\overline{\rho}p_X < \overline{\rho}h(q_A) = P_A$, then $q_X < q_A$: the country that unexpectedly sees its export market open and has its welfare decrease initially, over time sees its exports (and industry production) decrease, *i.e.*, its export industry *contracting* over time. In this case, while welfare increases over time, it is still lower than autarkic welfare.

When, instead, there is high quality on the home market in both periods, first recall that in the long run with trade, the marginal entrant reduces home welfare (Proposition 7). Further, since the export price is above the autarkic price, in the long run more firms enter. More entry means less high quality on the home market: as $q_X > q_A$, $\hat{q}_H$ with entry is less than $\hat{q}_H$ with autarky (6) since $\partial\hat{q}_H/\partial q \leq 0$; home consumers are further harmed in the long run. On the other hand, there is more export and so producer surplus increases. Unfortunately, we could not obtain a meaningful condition for welfare to decrease in the long run. Yet, for all parameter values examined with linear demand and cost, we found that when trade reduces welfare in the short run, then it *further* reduces welfare in the long run, leaving us with:

Conjecture 1 *With linear demand and cost, and when there is high quality on the home market in equilibrium, if $W_A(q_A) > W_T(q_A)$, then $W_T(q_A) > W_T(q_X)$: if autarkic welfare is greater than trade welfare in the short run, then trade welfare decreases in the long run.*

In addition, there are parameter values such that short run trade welfare is greater than autarkic welfare ($W_T(q_A) > W_A(q_A)$), but autarkic welfare is still greater than long run trade welfare ($W_A(q_A) > W_T(q_X)$). The government then would like to promise autarky, but has a time inconsistency problem as it would like to allow trade in stage-two.[21]

We next examine what may occur when the type of stage-two equilibrium depends on whether firms expected trade. Specifically, consider export prices such that short run trade based on the autarkic level of entry (q_A), results in an equilibrium that has some high quality

[21]This is the reverse of the usual time consistency problem where governments profess free trade policy, but then protect an industry (e.g., Miyagiwa and Ohno 1995).

on the home market. In the second period, there would be more entry so long as the home price equals the export price. However, more entry creates a downward pressure on the home price and if entry is sufficiently great, there may not exist an amount of high quality on the home market such that the home price equals the export price (which occurs if $p_X > \hat{p}_X$). As a result, the only equilibrium now is *all* high quality being exported. Since the welfare harm to the home market is increasing in its loss of high quality output, it is possible then that welfare decreases in the long run with the adjustment of entry decisions:

Proposition 9 *If $\hat{p}_X < P_A/\overline{\rho} = h(q_A)$, then there exist export prices such that home welfare with trade in the short run is greater than trade in the long run: $W_T(q_A) > W_T(q_X)$.*

That such $\hat{p}_X$ can exist and that welfare with trade can be greater in the short run even when the condition in the proposition does not hold (*i.e.*, $\hat{p}_X > P_A/\overline{\rho}$) is shown next.

Linear Demand and Cost. In these examples, there is an equilibrium with some high quality in the home market in the short run (q_A). In this case welfare is $W_T(q_A)$ defined by (15). As $q_A = \overline{\rho}/(\overline{\rho}+\overline{c})$,

$$W_T\left(\frac{\overline{\rho}}{\overline{\rho}+\overline{c}}\right) = p_X\left(\frac{\overline{\rho}^2}{\overline{\rho}+\overline{c}} - \hat{q}_H\right) + \int_0^{\hat{q}_H+(1-\overline{\rho})\frac{\overline{\rho}^2}{\overline{\rho}+\overline{c}}} \frac{\hat{q}_H}{\frac{(1-\overline{\rho})\overline{\rho}}{\overline{\rho}+\overline{c}}+\hat{q}_H}(1-x)dx - \int_0^{\frac{\overline{\rho}}{\overline{\rho}+\overline{c}}} \overline{c}x dx.$$

The *unique* trade equilibrium in the long run has all high quality exported, so $q_X = \overline{\rho}p_X/\overline{c}$ and $W_T(\overline{\rho}p_X/\overline{c}) = p_X^2\overline{\rho}^2/2\overline{c}$. With this we have:

Example 3

$\overline{\rho}$	$\overline{c}$	p_X	q_X	P_A	q_A	$\hat{p}_X$	$W_T(q_X)$	$W_T(q_A)$
0.9	1	0.6	.54	.47	.47	.58	.15	.20
0.8	.4	0.4	.8	.267	.6	.34	.13	.23
0.7	.1	0.2	1.4	.09	.875	.13	.09	.27
0.6	.5	0.28	.34	$.\overline{27}$	.55	.28	.03	.15
0.5	.4	0.223	.28	$.2\overline{2}$	$.5\overline{5}$	.22	.02	.14

Note that when $\overline{\rho} = 0.7, .8, .9$, $\hat{p}_X > P_A/\overline{\rho}$, output increases and welfare still decreases.

5 Investments in Quality Improvement

We now extend our model to allow firms to invest in quality. The model is as in the previous section except that when a firm chooses whether to enter it also chooses whether to invest to increase the fraction of high quality output from $\overline{\rho}$ to ρ_I, $\overline{\rho} < \rho_I$. The investment increases an entrant q's entry cost: $e_I(q) > e(q)$.

It is useful to begin by considering what occurs if in the home market quality was observable. In this case, an entrant q would choose to invest so long as

$$\rho_I p - e_I(q) > \overline{\rho} p - e(q),$$

where p is the stage-two price. It is assumed that investing is efficient for all firms that would enter: $\rho_I / e_I(q) \geq \overline{\rho}/e(q)$, that is, with complete information all entrants would invest.

5.1 Autarky

With autarky stage two does not change: all firms choose not to sort and all quality receives the same price. Thus, in stage one it is more profitable to not invest:

$$p - e_I(q) < p - e(q). \tag{20}$$

The autarkic equilibrium, then, is unchanged from the previous section: $\overline{\rho} h(q_A) = e(q_A)$ and welfare is the same.

5.2 Trade

Consider first the stage-two equilibrium that has some high quality on the home market. In this case, all firms – whether they export or not – receive the same price for their high and low quality product. As a result, if such an equilibrium is expected in stage one, then it is expected that low and high quality receives the same price. By (20) all firms would choose not to invest. Thus, the key results (and examples) from the previous section for when there is high quality on the home market still hold even with moral hazard in investment:

Proposition 10 *If entrants can make a costly, but efficient investment to increase the fraction of high quality and in equilibrium there is high quality on the home market:*

1. *no firms make the efficient investment,*
2. *there exist export prices such that welfare decreases from exporting,*
3. *home welfare is harmed by the marginal entrant, and*
4. *welfare can be greater in the short run than the long run trade equilibrium.*

In addition, there is Conjecture 1: when autarkic welfare is greater than short run trade welfare, then short run trade welfare is greater than long run trade welfare.

Turning to when in stage one firms expect all high quality to be exported, the efficiency assumption ($\rho_I/e_I(q) \geq \overline{\rho}/e(q)$) implies that investing is more profitable for any entrant:

$$p_X\rho_I - e_I(q) > p_X\overline{\rho} - e(q).$$

As a result, the new entry level, denoted q_I is now defined by

$$p_X\rho_I - e_I(q) = 0.$$

As all high quality is exported, welfare is simply producer surplus:

$$p_X\rho_I q_I - \int_0^{q_I} e(x)dx.$$

Despite firms making efficient investments, previous results (specifically, the proof to Lemma 2) suggest that there still exist export prices that reduce welfare. For example, as $e(q) \to e_I(q)$ and $\overline{\rho} \to \rho_I$, there can exist export prices such that welfare and even producer surplus can decrease. The potential for this to occur in a non-trivial way is more clearly seen by considering the linear demand and cost case.

> **Linear Demand and Cost.** As before let $h(q) = 1 - q$ and $e(q) = \overline{c}q$, but now let $e_I(q) = c_I q$, $\overline{c} < c_I$. The efficiency condition implies that $\rho_I/c_I \geq \overline{\rho}/\overline{c}$ for profitable entry. Since no firm invests, autarkic producer surplus and welfare is as previously determined in Section 4: $PS_A(\overline{\rho}) = \overline{c}\,\overline{\rho}^2/2(\overline{\rho} + \overline{c})^2$ and $W_A(\overline{\rho}) = \overline{\rho}^2/2(\overline{\rho} + \overline{c})$.

When instead all high quality is exported in stage two, firms enter until $\rho_I p_X - c_I q = 0$ and welfare is simply producer surplus:

$$W_I(\rho_I) = PS(\rho_I) = p_X \rho_I \frac{\rho_I p_X}{c_I} - \int_0^{\frac{\rho_I p_X}{c_I}} c_I x dx = p_X^2 \rho_I^2 / 2c_I.$$

Algebraic manipulation yields that producer surplus is greater with autarky ($PS(\overline{\rho}) > PS(\rho_I)$) if $p_X < p_X^{PS} \equiv \overline{\rho}(\overline{c} c_I)^{1/2}/\rho_I(\overline{c}+\overline{\rho})$. For welfare it is $p_X < p_X^W \equiv \overline{\rho}(c_I)^{1/2}/\rho_I(\overline{c}+\overline{\rho})^{1/2}$. Additional algebraic manipulations show that such prices always exist: $p_X^{PS} > P_A(\overline{\rho}) \equiv \overline{\rho}\,\overline{c}/(\overline{\rho}+\overline{c})$. The next examples suggest how much greater p_X can be than P_A and producer surplus or welfare still decreases with trade even though investment significantly increases high quality.

Example 4

$\overline{\rho}$	$\overline{c}$	ρ_I	c_I	$\overline{\rho}/\overline{c}$	ρ_I/c_I	p_X^{PS}/P_A	p_X^W/P_A
0.1	0.5	0.9	1.0	0.2	0.9	1.57	1.72
0.1	0.5	0.9	2.0	0.2	0.45	2.22	2.43
0.1	0.5	0.9	3.0	0.2	0.3	2.72	2.98
0.1	0.5	0.9	4.0	0.2	0.225	3.14	3.44

Intuitively the price ratios increase as the return to investment decreases as then it takes a higher export price to make trade welfare improving. We conclude with

Proposition 11 *If entrants can make a costly, but efficient investment to increase the fraction of high quality and all high quality is exported, then all firms invest in quality improvement and with linear demand and entry cost there exists export prices such that home producer surplus and welfare decrease with exporting.*

6 Conclusion

International trade is generally welfare improving and it is an important means by which lesser developed economies can grow. For countries with weak institutions, trading partners with strong institutions can also offer a means to circumvent the barriers to growth associated with weak institutions.

We examine a model in which, because of weak institutions, a home market is characterized by asymmetric information in product quality. Trade allows the home firms to bypass this and earn a higher return on their high quality products. Despite this, we find that such trade may harm the home country. This was found both in the short run when the opening of export markets is unexpected and in the long run when home exporters could respond through entry and investment in quality. The intuition for this is simple: in markets with asymmetric information regarding product quality the price is determined by the *marginal* consumer's expected value of the product. However, when a unit of high quality is exported, the loss in home welfare is the *average* consumer's value of the high quality product since in the home market which consumer would have received the high quality product is random. This harm is increasing in the amount exported, as the average valuation for quality is increasing as home sales decrease. Thus, if some high quality remains on the home market then on the margin the export of high quality *always* harms the country. Indeed, trade can lead to an expansion of the export sector and home welfare can still decrease, an immiserizing growth from asymmetric information. Finally, when it is the case that autarky yields greater welfare than trade in the long run (*i.e.*, when entry decisions are accounted for), the home government can face a time inconsistency problem: after firms make their entry decisions expecting autarky the home country may prefer to unexpectedly allow trade.

The welfare harm from trade need not be solely from the harm to consumers as home firms can also be made worse-off. This can occur when all high quality is exported. The reason is that the home price declines when only low quality remains, and only a fraction of home firms' product receives the higher export price. Thus, if the autarkic home price is greater than the weighted average of the prices with export, then producer surplus decreases. This implies that in the very long run the export industry could contract and high quality output can *decline*. Specifically, the country that unexpectedly sees its export market open and has its welfare decrease initially, over time sees its exports (and industry production) decrease, *i.e.*, its export industry *contracting* over time. It is even possible that a country that sees its welfare increase initially from trade, can see it decrease over time.

For the trade to harm the home country, the export price must be below the choke price for high quality in the home country (*i.e.*, if the reservation price for the consumer in the home country who values high quality the most is less than the export price, then exporting increases home welfare). To the extent country income determines consumers' reservation prices, a sufficiently low income country relative to the export market (so the highest reservation price is below the export price) would not face this potential harm from export but a slightly higher income country could. So, if the opening of the export market for this sufficiently low income country increases its income, over time it could then move into the region where the high quality export harms the home country as its consumers become wealthy enough to demand the high quality product.

Appendix

Lemma 1 *The maximum* ***feasible*** *home price $P^F(q)$ is decreasing in entry q.*

Proof. To establish this we need a preliminary Lemma and its Corollary. Specifically, we need to compare the home market price when there are equal levels of output on the home market and *different* levels of entry (hence different amounts of high quality are exported). That is, consider two levels of entry q_1 and q_2, and denote the amount of high quality on the home market with the first level of entry as q_{1H}. Define $\hat{q}_{2H}(q_{1H})$ as the level of high quality on the home market with the second level of entry such that total output on the home market is equal: $q_{1H} + (1-\overline{\rho})q_1 = \hat{q}_{2H}(q_{1H}) + (1-\overline{\rho})q_2$.

> **Lemma A** *Consider two levels of entry q_1 and q_2, with $q_1 < q_2$, then for the same amount sold on home market the home price is always lower with the higher level of entry: $P(q_{1H}, (1-\overline{\rho})q_1) > P(\hat{q}_{2H}(q_{1H}), (1-\overline{\rho})q_2)$.*
>
> **Proof.**
>
> $$P(q_{1H}, (1-\overline{\rho})q_1) = \frac{q_{1H}}{q_{1H} + (1-\overline{\rho})q_1} h(q_{H1} + (1-\overline{\rho})q_1)$$
> $$> \frac{\hat{q}_{2H}(q_{1H})}{\hat{q}_{2H}(q_{1H}) + (1-\overline{\rho})q_2} h(\hat{q}_{2H}(q_{1H}) + (1-\overline{\rho})q_2) = P(\hat{q}_{2H}(q_{1H}), (1-\overline{\rho})q_2).$$
>
> as $q_{1H} + (1-\overline{\rho})q_1 = \hat{q}_{2H}(q_{1H}) + (1-\overline{\rho})q_2$, and $q_{1H} > \hat{q}_{2H}(q_{1H})$ since $(1-\overline{\rho})q_1 < (1-\overline{\rho})q_2$. ■
>
> When there exist a unique q_H on the home market that maximizes the home price (*i.e.*, $q_H^*(q_L)$),[22] then Lemma A implies
>
> **Corollary A** *The maximum home price $P(q_H^*(q_L), q_L)$ is decreasing in entry.*
>
> To see why the corollary follows, consider for the greater level of entry (q_2) the amount of high quality on the home market that maximizes the home price: $q_H^*((1-\overline{\rho})q_2)$. However, by Lemma A, with less entry (q_1) the same aggregate output ($q_H + (1-\overline{\rho})q_1 = q_H^*((1-\overline{\rho})q_2) + (1-\overline{\rho})q_2$) on the home market yields

[22] Note that the existence of $q_H^*(q_L)$ is a weaker assumption than unimodality, *i.e.*, unimodality need not hold for for there to be a $q_H^*(q_L)$.

a greater price, say $\hat{P}$. This latter price is by definition less than the maximum price given entry q_1: $\hat{P} \leq P(q_H^*((1-\overline{\rho})q_1), (1-\overline{\rho})q_1)$.

Note that the price in Corollary A may not always be feasible. However, the continuity of $P_1(q_H, q_L)$, Corollary A and $P'(q) < 0$ imply that the maximum feasible price is also decreasing in entry. Consider the case when for some level of entry $\check{q}$, $P_1(\rho\check{q}, (1-\rho)\check{q}) > 0$. For the range of entry q around $\check{q}$ in which q_H^* is not feasible the maximum feasible home price is the entry level, which is clearly decreasing in entry. If the range of entry that satisfies this is the entire range, the proof is complete. If not, then by continuity at the limit of the range there is a q, $\dot{q}$, such that $P_1(\rho\dot{q}, (1-\rho)\dot{q}) = 0$ and at this limit point the maximum feasible home price is still decreasing in entry. If beyond $\dot{q}$, there is a range of q such that $P_1(\rho\check{q}, (1-\rho)\check{q}) < 0$, then by Corollary A, the maximum feasible home price is decreasing in entry. The identical logic applies if there are any other levels of entry q such that $P_1(\rho q, (1-\rho)q) = 0$. ■

Proposition 5 *Welfare is greater with autarky than with trade when the condition in Proposition 2 holds for q_X.*

Proof. If proposition 2 holds for q_X, then given entry level q_X welfare is greater with no trade (denoted $W_A(q_X)$) than with trade (subscript T for emphasis): $W_A(q_X) > W_T(q_X)$. Since q_A is the (information-constrained) optimal level of entry without trade then $W_A(q_A) \geq W_A(q_X) > W_T(q_X)$. ■

Lemma 2 *There exist export prices such that home producer surplus (hence, welfare) when all high quality is exported is lower than producer surplus with autarky.*

Proof. Producer surplus with autarky less producer surplus with entry is

$$P_A q_A - \int_0^{q_A} e(x)dx - \left[p_X\overline{\rho}q_X - \int_0^{q_X} e(x)dx\right] = \left(P_A(q_A - q_X) - \int_{q_X}^{q_A} e(x)dx\right) + [P_A - p_X\overline{\rho}]q_X. \tag{21}$$

When $p_X \leq P_A/\overline{\rho} > P_A$, then $q_X \leq q_A$, so the parenthetical term in (21) is positive since $P_A = e(q_A)$ by the entry condition and so (21) is positive. ■

Lemma 3 *There exist export prices such that welfare is lower when in equilibrium there is high quality on the home market than it is with autarky.*

Proof. Evaluating (19) at $p_X = P_A$ yields

$$\begin{aligned} W_T'(P_A) = {} & [\overline{\rho}q_A - \overline{\rho}q_A] + P_A[\overline{\rho}q_X' - \hat{q}_H'q_X'] \\ & + [\hat{q}_H' + (1-\overline{\rho})]q_X'\overline{\rho}h(q_A) \\ & + \int_0^{q_A} \frac{(1-\rho)(\hat{q}_H'q_X'q_X - q_X'\hat{q}_H)}{(\hat{q}_H + (1-\rho)q_X)^2}h(x)dx - q_X'e(q_A). \end{aligned}$$

Since $\overline{\rho}h(q_A) = P_A$, this simplifies to

$$W_T'(p_X) = P_Aq_X' + \int_0^{q_A} \frac{(1-\rho)(\hat{q}_H'q_X'q_X - q_X'\hat{q}_H)}{(\hat{q}_H + (1-\rho)q_X)^2}h(x)dx - q_X'e(q_A) < 0,$$

since from the entry condition $P_A = e(q_A)$, $q_X' > 0$ and $\hat{q}_H' < 0$. ■

Proposition 7 *In the two-stage game (long run), home welfare is harmed by the marginal entrant if in equilibrium there is high quality on the home market.*

Proof. Expressing home welfare (18) as a function of entry (q) gives

$$W_T(q) = p_X[\overline{\rho}q - \hat{q}_H(q)] + \int_0^{\hat{q}_H(q)+(1-\overline{\rho})q} \frac{\hat{q}_H(q)}{\hat{q}_H(q) + (1-\overline{\rho})q}h(x)dx - \int_0^q e(x)dx.$$

Differentiating we obtain

$$\begin{aligned} W_T'(q) = {} & p_X[\overline{\rho} - \hat{q}_H'(q)] + [\hat{q}_H'(q) + (1-\overline{\rho})]p_X \\ & + \int_0^{\hat{q}_H(q)+(1-\overline{\rho})q} \frac{(1-\rho)(\hat{q}_H'(q)q - \hat{q}_H)}{(\hat{q}_H(q) + (1-\rho)q_X)^2}h(x)dx - e(q). \end{aligned}$$

where the second p_X comes from the home price equaling the export when some high quality is on the home market. As the integral is negative (high quality exports reduces the average quality on the home market and at $q_X, p_X = e(q_X), W_T'(q_X) < 0$. ■

Proposition 8 *When in equilibrium there is high quality on the home market, home welfare decreases in the export price at $\hat{p}_X$.*

Proof. For a given export price, home welfare with all exporting (16) less home welfare some exporting (18) is

$$p_X\hat{q}_H - \int_0^{\hat{q}_H} \frac{\hat{q}_H}{\hat{q}_H + q_L^X}h(x)dx < 0$$

since by definition $\frac{\hat{q}_H}{\hat{q}_H+q_L^X}h(\hat{q}_H+q_L^X)=p_X$. As $d\hat{q}_H/dp_X<0$ there is a maximum export price $\hat{p}_X$ such that there is an equilibrium with some high quality on the home market. As $P_1(0,q_L^X)>0$, $\hat{q}_H(\hat{p}_X)>0$ so at $\hat{p}_X$, and increase in p_X results in all high quality being exported and home welfare decreasing. ■

Lemma 4 *A.If all high quality exported is the unique short run trade equilibrium when autarky is expected, then all high quality exported is the unique long run trade equilibrium. B. If there is a long run trade equilibrium with high quality on the home market, then there is a short run trade equilibrium when autarky is expected with high quality on the home market.*

Proof. A. Assume there exist a long run trade equilibrium in which some high quality sells on the home market when the unique short run trade equilibrium with autarky had all high quality exported. In this case, the home price must equal the export price. Let q_L^X (defined by 12) denote the amount of low quality associated with this entry equilibrium. By Lemma 1, since $q_L^X>q_L^A$, then $P^F(q_A)>P^F(q_X)$. As $p_X>P^F(q_A)$, there is a contradiction: there does not exist a long run trade equilibrium with some high quality on the home market. B. There exist $\hat{q}_H(q_X)$. Since $p_X>P_A$, $q_X>q_A$. Since $\partial q_H/\partial q<0$, $\hat{q}_H(q_X)$ is feasible when q_A firms enter and $P(\hat{q}_H(q_X),q_L^A)>p_X$ since $\hat{q}_H(q_X)+q_L^X>\hat{q}_H(q_X)+q_L^A$. As the home price is continuous in q_H there exist a feasible q_H such that $P(q_H,q_L^A)=p_X$. ■

Proposition 9 *If $\hat{p}_X<P_A/\overline{\rho}=h(q_A)$, then there exist export prices such that home welfare with trade in the short run (q_A) is greater than trade in the long run (q_X).*

Proof. As $p_X\to\hat{p}_X$ (the maximum export price such that there is an equilibrium with some high quality sold on the home market) from above, the only equilibrium has all high quality exported. Since $q_A<q(p_X^*)$ for $p_X^*>\hat{p}_X$, where $q(p_X^*)$ is the entry level *if* p_X^* were the home equilibrium price, and $\partial\hat{q}_H/\partial q<0$, then there is a short run trade equilibrium with some high quality on the home market for p_X sufficiently close to $\hat{p}_X$ from above. Since $\hat{p}_X<P_A/\overline{\rho}$, for p_X sufficiently close to $\hat{p}_X$, producer surplus is greater in the short run trade equilibrium and hence home welfare is greater in the short runt trade equilibrium than in the long run trade equilibrium. ■

References

[1] Acemoglu, Daron, Simon Johnson and James A. Robinson. 2001, "The Colonial Origins Of Comparative Development: An Empirical Investigation," American Economic Review, 2001, 91(5), 1369-1401.

[2] Acemoglu, Daron, Simon Johnson, and James Robinson, 2005, "Institutions as a Fundamental Cause of Economic Growth." In the Handbook of Economic Growth, ed. Philippe Aghion and Steven Durlauf, 385–465. Amsterdam: Elsevier.

[3] Acemoglu, Daron, Pol Antràs and Elhanan Helpman, 2007. "Contracts and Technology Adoption." American Economic Review 97(3), 916-943

[4] Alchian, Armen A. and William R. Allen, University Economics. Belmont, CA: Wadsworth Publishing Company, 1964.

[5] Antras, Pol, 2005, "Incomplete Contracts and the Product Cycle," American Economic Review, 95, 1054-1073.

[6] Bagwell, K., 1991, Optimal export policy for a new-product monopoly, American Economic Review, 81(5), 1156-1169.

[7] Bagwell, K. and M. Riordan, 1991, High and declining prices signal quality, American Economic Review, 81(1), 224-239.

[8] Costinot, Arnaud, 2009, "On the origins of comparative advantage," Journal of International Economics 77, 255-264.

[9] Creane, Anthony and Jeitschko, Thomas D., 2012 "Endogenous Entry in Markets with Adverse Selection," EAG Discussion Paper.

[10] Crozet, Matthieu, K. Head and Thierry Mayer, Quality sorting and trade: Firm-level evidence for French wine, Review of Economic Studies, 2012, 79(2), 609-644.

[11] Etro, F. (2011), Endogenous Market Structures and Strategic Trade Policy, International Economic Review, 52: 63–84

[12] Feenstra, Robert C. and Gordon H. Hanson, 2004, Intermediaries in Entrepot Trade: Hong Kong Re-Exports of Chinese Goods, Journal of Economics & Management Strategy, 13(1), 3-35.

[13] Grossman, G. and E. Helpman, 1991, Quality Ladders and Product Cycles, Quarterly Journal of Economics 106(2), 557-586.

[14] Grossman, G.M. and H. Horn, 1988, Infant-Industry Protection Reconsidered: The Case of Informational Barriers to Entry, Quarterly Journal of Economics, 103(3), 768–787.

[15] Hallak, J.C., and P.K. Schott, 2011, Estimating Cross-Country Differences in Product Quality, The Quarterly Journal of Economics, 126(1), 417-474.

[16] Hausmann, R. J. Hwang and D. Rodrik, 2007, What you export matters, Journal of Economic Growth, Springer, vol. 12(1), pages 1-25, March.

[17] Hummels, D. and A Skiba,2004, Shipping the Good Apples Out? An Empirical Confirmation of the Alchian-Allen Conjecture, Journal of Political Economy, 112(6), 1384-1402.

[18] Hummels, D. and P.J. Klenow, 2005, The Variety and Quality of a Nation's Exports, American Economic Review, 95(3), 704-723.

[19] Kaufmann, D., A. Kraay and M. Mastruzzi, 2009, "Governance Matters VIII: Aggregate and Individual Governance Indicators 1996–2008" World Bank Working Paper 4978.

[20] Khandelwal, A., 2010, The Long and Short (of) Quality Ladders, Review of Economic Studies, 77(4), 1450-1476.

[21] Johnson, R.C. and G. Noguera, 2012, Accounting for intermediates: Production sharing and trade in value added, Journal of International Economics, 86(2), 224-236.

[22] Ju, Jiandong, and Shang-Jin Wei, 2010, Domestic Institutions and the Bypass Effect of Financial Globalization, American Economic Journal: Economic Policy, 2(4): 173204.

[23] Levchenko, Andrei, 2007, "Institutional quality and International Trade," Review of Economic Studies 74(3), 791-819.

[24] Levchenko, Andrei, 2011, "International Trade and Institutional Change," NBER Working Paper No. 17675 December 2011.

[25] Miyagiwa, Kaz and Yuka Ohno, 1995, Closing the Technology Gap Under Protection, The American Economic Review, Vol. 85, No. 4, pp. 755-770

[26] Rodrik, D., A. Subramanian and F. Trebbi, 2004, "Institutions Rule: The Primacy of Institutions Over Geography and Integration in Economic Development," Journal of Economic Growth, 9(2), 131-165.

[27] Spence, M., 1975, Monopoly, quality and Regulation, The Bell Journal of Economics, 6, 417-429.

[28] Spence, M., 1976, Product Differentiation and Welfare, American Economic Review, 66, 407-414.

[29] Vogel, Jonathan, 2007, Institutions and moral hazard in open economies, Journal of International Economics, 71(2), 495-514

[30] Young, Alwyn, 1999, Transport, Processing and Information: Value Added and the Circuitous Movement of Goods, working paper, University of Chicago.