BASEBALL AND TARIFFS: ESSAYS ON ECONOMIC ANALYSIS

By

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To my mother

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Institutions play a major role in many economic settings. The rules that economic actors follow shape their behavior, regardless of whether these rules are set by a regulatory body, the government, or convention. It is interesting to examine scenarios in which these rules lead to unexpected economic outcomes.

Chapter 1 examines the role of tariffs in national welfare. In Chapter 1 I develop a monopolistically competitive model of one-way trade flows with firm heterogeneity across marginal costs in order to endogenize the competitiveness of the market. I use these endogenous variables to analyze how trade policy impacts the welfare of consumers in a small country. In this model, I introduce fixed exporting costs to address the role they play in terms of welfare in the face of trade policy. Both fixed exporting costs and tariffs directly influence the competitiveness of the exporting market. In simulations, this model predicts that in the presence of fixed exporting costs, tariffs actually reduces welfare less than when fixed exporting costs are absent. This model is useful for expanding on previous work regarding how fixed exporting costs can impact welfare in small countries.

In Chapter 2 I expand on existing research regarding settlement failures in labor contract negotiations. Testing two proposed explanations (error in player evaluation vs. differing levels of risk aversion), I find that each plays a role in failed negotiations within the context of final offer arbitration in Major League Baseball. It appears that when players submit offers during arbitration, they take on higher levels of risk than the negotiating team. At the same time, it appears that clubs tend to better predict the arbitrator's preferences. Thus aggressive offers on the part of players lead to lower salaries. An aggressive offer by the ball club also results in lower salaries as well. In addition, I look at how behavior changes with experience, and find that with experience players are likely to estimate the arbitrators'' perception of their value much more accurately.

CHAPTER 1
A NEW LOOK AT NEW GOODS: EXAMINING THE INTERACTION BETWEEN TARIFFS AND FIXED EXPORT COSTS

1.1 Introduction

The aim of this paper is to look at welfare as it relates to barriers to trade. Although most analysis of welfare in trade models focuses on tariffs, I look further at the role of fixed costs that may be associated with exporting. These fixed costs of exporting can be thought of as the required license to begin serving a foreign market, the costs of setting up contracts in the foreign market, or even general red tape that must be overcome. That is they can be thought of as stemming from natural or unavoidable causes associated with entering a market or as fixed costs imposed by the government of the importing country's government. By looking at the interaction between tariffs and these institutional barriers, I hope to expand upon the existing literature in trade theory.

The introduction of fixed export costs does serve to complicate the analysis. I develop a monopolistically competitive model where firms are heterogeneous across their marginal cost of production. This paper looks specifically at the interaction of tariffs and fixed exporting costs in relation to a relatively small country. I choose to focus on a small country scenario for two reasons. First and foremost, as shown by Guiso et al (2009), institutional quality can cause an important obstacle to successful international trade. This means that the questions in this paper are most directly applicable to smaller, developing countries. In addition, this allows a believable scenario for one-way trade flows. It is worth noting that, while the country under examination is likely small; it is more appropriate to think of this discussion in terms of North-South interaction.

For the purpose of this paper, I focus specifically on a monopolistically competitive final good market. The good is produced in the world at large (which we can think of as the North) and imported by the South. The South has no production capabilities of the differentiated good. This is very realistic assumption, in that many developing countries rely on imports for the supply of goods. The idea of one-way trade flows greatly increases the tractability of the model as well. I am able to distill the model down to a system of equations that describe the market equilibrium. Using these equations, I conduct numerical simulations to describe and analyze a range of possible economic scenarios.

In this paper, I take ideas pioneered by Romer (1994), and apply them in a modern framework. In order to incorporate the modern analysis of the idea that welfare effects depend on the fixed costs of exporting, I turn to Melitz and Ottaviano (2008), Ottaviano, Tabuchi, and Thisse (2002), and Behrens et al. (2007). From this work, I develop a model that utilizes horizontal product differentiation and quasi-linear demand functions to illustrate the impact of fixed costs associated with exporting. In order to separate the entry decision and the export decision, the model incorporates random cost draws. The cost cutoffs that I derive for firms to stay active and to export then allow analysis of the effects of introducing taroffs on export varieties.

This model relies heavily on the basic model of the world as developed by Romer. There is a small country that imports a unique set of varieties from the rest of the world. In order to keep results directly comparable to the original, I assume that the small country has zero domestic production, with all consumption of the varied good coming from imports. By applying a quasi-linear demand function, it is possible to measure the interaction of fixed export costs and tariffs in determining the welfare of citizens in the small country. This allows direct comparison of effects across models.

Although the goal is to re-examine Romer's model, there is a clear distinction between the two. I look at two possible scenarios, one where fixed costs of exporting do not exist and one where they do. This analysis actually diverges from Romer's work. Although he states that fixed costs play a large role in welfare, there is some question as to whether his analysis truly addresses this issue. I look at both the scenario addressed in Romer, and one that analyzes the role of fixed costs more specifically.

In order to address this issue clearly, I start by introducing the two economies with zero fixed costs, while keeping in mind that relative size may play a key role in the effects of fixed costs. While the small country (which I will refer to as foreign or simply *F*, but which should be thought of as the South) is completely reliant on the rest of the world (home or *H*) for the varied good[1], it is important to note that market size may still play a crucial role. The nature of the model implies that it is possible that market size may change export decisions by Home based producers. After an introducing the basic layout of the model, I present the final one-way trade equilibrium. Here, the possibility of fixed export costs complicates the issue. While Melitz and Ottaviano find a very elegant solution, once fixed costs of export are introduced, exporters face a much more daunting proposition. In the absence of fixed costs, zero demand conditions clearly drive the cost cut offs for exporters. With fixed costs, however, there enters a discontinuous jump from positive to zero demand. In Melitz and Ottaviano, the marginal

[1] In other words, the small country relies on the rest of the world for its imports.

exporter supplies only a small quantity, so the impact of changes in the number of exporters is a minor one.

After developing the equilibrium conditions, simulations become necessary. The complications mentioned above prevent me from finding a closed form solution of the equilibrium. In lieu of analytical solution, I turn to simulations of the role that fixed costs and tariffs play in determining welfare.

The predictions of the model stand in stark contrast to those of Romer. While his model relied on an intermediate good that had repercussions for final good production, this model relies on varieties of a final good. That, when combined with the quasi-linear demand, predicts a completely different view of fixed costs. In Romer's model, demand is derived from a Cobb-Douglas production function in the final goods market. Here consumer preferences drive demand. I find that an addition of a fixed cost of exporting actually mitigates the effect of a tariff on welfare, while Romer finds that adding fixed costs[2] increases the impact of a tariff on welfare. This occurs because in this model productivity plays a greater role in export decisions. The fixed cost plays a large role in discouraging exporters, while the higher tariff only plays a secondary role, a result I verify across a large range of parameter specifications.

This model relies on market size and demand parameters to derive endogenous results for the number of firms in the Home country, the cost cut off for production by domestic only producers, and the cost cut off for firms that choose to export. The heterogeneous nature of costs creates a dynamic situation where only a subset of firms

[2] Adding fixed costs effectively introduces a long run vs. short run scenario. Firms that have already sunk their fixed cost of exporting remain in the foreign market as long as they're covering their marginal costs. In the long run however, firms will take the differing fixed cost into account and only enter the foreign market if they can cover marginal costs and recoup their fixed costs.

chooses to export. As in previous work by Melitz (2003) and other recent work, this study finds that more efficient firms charge higher mark-ups, which are, again, uniformly distributed across firms. Also, I confirm findings from previous work that more efficient firms both export and supply domestically, moderately efficient firms produce for the domestic market, and the least efficient firms simply exit the market upon learning their cost. However, when compared to similar sized tariffs, fixed costs of export are more influential in removing potential exporters.

The results from this analysis clearly show that if consumer preferences can be modeled with a quasi-linear utility function, the role of tariffs in consumer welfare shrinks. Using a modified version of the model presented by Meltiz and Ottaviano, I find that introducing fixed exporting costs actually causes tariffs to impact welfare much less than might be expected. In addition, I find that this model according to expectations when looking at short run versus long run exporting decisions. When the number of firms exporting is reduced by tariffs, the resulting harm to welfare is greater than when the number of exporters is fixed.

The remainder of the paper unfolds in the following sections. First, I give a brief review of previous literature. Next I present the model, and develop some preliminary analytical results. The third section outlines the simulation approach and presents the results from these simulations. Finally, the findings from this paper are compared to Romer's, and the effect of modifying the Melitz-Ottaviano Model is discussed.

1.2 Previous Work

It is important to have a basic understanding of Romer's earlier work. In his paper, Romer posits the idea that when analyzing welfare as it relates to trade, many economists focus primarily on losses due to increases in price. At the same time, they ignore the very real issue that tariffs and trade barriers may also reduce the number of firms in the market. His concern is that when fixed costs are present, tariffs may drive firms out of the market, exacerbating welfare losses.

Romer uses a two-region model. The first region represents the world at large while the second represents a small country. The small country produces a final good that relies on inputs imported from the world economy. The small country produces the final good under a many goods version of an additively separable production function. Differentiation among firms stems from the fact that each firm faces a unique fixed cost of entering the small country market.

This model allows Romer to derive the endogenous equilibrium number of exporting firms located in the world. Romer then derives consumer welfare for the small country. This welfare measure is then used to look at the impact of a tariff on consumers.

Romer addresses two regimes in his paper. Although his main focus is on fixed costs of exporting, his final analysis looks instead at long run versus short run welfare. In his first simulation, he assumes that the number of exporters is fixed before the announcement of a tariff. That is, firms make their entry decisions while unaware of the tariff. In the second regime firms are aware of the before entry. In contrast to the first case, here the number of firms serving the small country falls with the addition of a tariff.

Romer finds that with an introduction of a tariff of 10%, national income falls by roughly 1% when the number of exporters is fixed. When Romer allows the number of exporters to vary, this number jumps to 19.81%. As there is no numeraire good in his model, all welfare is depends directly on imports. In addition, firm differentiation along the fixed cost of exporting dimension necessarily means that welfare losses will be small when the number of firms is fixed. In contrast, in this model it does not make sense to fix the number of exporting firms, as firms are differentiated over marginal costs instead of fixed exporting costs.

Although the model points out that the number of firms is an important determinant of consumer welfare, this seems to miss a more compelling point about the role that fixed costs of exporting play. I attempt to focus more intently on the discrete effect of fixed exporting costs on welfare. To do this I examine regimes that differ from Romer. In order to provide directly comparable results, I do conduct a classic short/long run analysis. However, the two scenarios of greatest interest focus on a world where there are no fixed costs of exporting in comparison to a world where there are. The number of firms will vary in both, so in essence this paper primarily focuses on the long run. For the sake of comparison, I also include analysis of the short run. These findings are exactly analogous to Romer's work.

It is important to note that the designation of a "small country" is probably not suitable in this scenario. Recent work such as Demidova and Rodriguez-Clarez (2011) makes it clear that our definition of a small country are inadequate in this setting. In the model to follow, I will focus on a scenario where one country faces limitations in production capabilities, but still has some ability to influence price through their demand. It is probably more appropriate to think of this analysis more in line with a traditional North-South analysis. One country represents the North and has production capabilities, while one country is developing and lacks some domestic production.

In order to address these questions, I modify the model presented by Melitz and Ottaviano. Many of the basic assumptions follow directly from their work. I also make use of a quasi-linear utility function similar to that used in Behrens et al. (2007). From this utility function I find the equilibrium price and quantity. The key modification is the inclusion of an additional cost of trade. Not only are tariffs and trade costs present in this model, fixed exporting costs also play a role in firms' exporting decisions. Finally, trade is limited to one-way flows. This allows me to address the issues of fixed cost of exporting specifically while using a more modern approach to trade theory.

Limiting trade flows to one direction implies that the South depends on the world market for the differentiated product. This assumption simplifies the analysis, but is also a practical consideration. For a substantial subset of goods, developing countries do depend on a world market, with little or no domestic production.[3] Adding fixed export costs introduces some complications. As will be shown in the following section, introducing an additional trade cost increases the impact of the marginal exporter. I find that as I allow the tariff and fixed exporting costs to vary, this increased weight on the marginal exporter has consequences on consumer welfare.

1.3 The Model

The model relies on consumer preferences. Keep in mind that, unlike Romer, I utilize a final goods market. This means that demand is driven by preferences instead of production functions. Preferences are defined over a continuum of differentiated varieties and a homogeneous good, which I choose as the numeraire. Consumers have

[3] One such example might be high-end consumer electronics.

identical preferences and these are consistent across countries. Preferences are given by the utility function:

$$U^F = q_0 + \alpha \int q_i di - \frac{1}{2}\gamma \int {q_i}^2 di - \frac{1}{2}\eta(\int q_i di)^2 \quad (1\text{-}1)$$

where q_0 represents consumption of the numeraire and q_i represents consumption of each variety *i*. Demand parameters are all positive. The parameters α and η give the substitution pattern between the differentiated varieties and the homogeneous good. An increase in α and a decrease in η both act to shift demand for varieties out relative to the numeraire. γ acts to measure product differentiation among varieties. That is, when $\gamma = 0$ consumers do not care about consuming differentiated varieties, they simply worry about their total consumption of all varieties in aggregate (represented by $Q = \int q_i di, \forall i \in q_i \geq 0$. At the limit when $\gamma = 0$, varieties act as perfect substitutes. As γ increases, consumers put increasing weight on consuming differentiated varieties.

1.3.1 Consumer Preferences

Given this utility function, consumers maximize their welfare over varieties and I can derive the demand for any good. This maximization problem yields an inverse demand of:

$$p_i^F = \alpha - \gamma q_i - \eta \int_0^{N_x^H} q_i di \quad (1\text{-}2)$$

It is then possible to find the total inverse market demand for varieties by consumers in the South:

$$q_i^F = (1-\theta)\left[\frac{\alpha}{\gamma+\eta N_x^H} - \frac{1}{\gamma}p_i^F + \frac{\eta}{(\gamma+\eta N_x^H)}\frac{1}{\gamma}\tilde{p}^F\right] \quad (1\text{-}3)$$

when there is a unit mass of consumers in the world. θ then represents the portion of consumers residing in *H* while $(1-\theta)$ gives the portion of consumers residing in *F*. $\tilde{p}$

represents a quasi consumer price index which I discuss later. The total number of varieties produced in the world market by firms in *H* is given by N^H. N_x^H represents the number of firms that actually export to *F*. Similar conditions hold for consumers in country *H*:

$$p_i^H = \alpha - \gamma q_i - \eta \int_0^{N^H} q_i di \tag{1-4}$$

$$q_i^H = \theta \left(\frac{\alpha}{\gamma + \eta N^H} - \frac{1}{\gamma} p_i + \frac{\eta}{(\gamma + \eta N^H)} \frac{1}{\gamma} \tilde{p}^H \right) \tag{1-5}$$

In addition firms' price is bounded by the price at which demand is driven to zero. Taking Equation 1-5 and solving gives the maximum price in *H*:

$$p_{max}^H = \frac{1}{\gamma + \eta N^H} (\gamma \alpha + \eta N^H \bar{p}^H) \tag{1-6}$$

So this represents the upper bound on prices charged by firms. Again this is relevant only to the domestic market in *H.* The market in *F* does not face a zero demand condition because supply is provided solely by firms in *H* that face a fixed exporting cost. It is clear that, domestically, an increase in average prices drives up the maximum price that firms can charge.

The primary focus is on consumers residing in *F*. Welfare can then be evaluated using the indirect utility function associated with Equation 1-1:

$$W = I + \frac{1}{2} \left(\eta + \frac{\gamma}{N_x^H} \right)^{-1} (\alpha - \tilde{p}^F)^2 + \frac{1}{2\gamma} \int \left(p_i^F - \frac{\tilde{p}^F}{N_x^H} \right)^2 di \tag{1-7}$$

where *I* represents consumers income. As will become important later, welfare increases as average prices decline. In addition, welfare also increases as product variety (N_x^H) increases, which illustrates the model's basis on preference for variety. In addition it can be seen (while holding the price index $\tilde{p}^F$ constant) that an increase in the variance of prices increases welfare. As the variance of prices increases, consumers substitute away from higher priced varieties to lower priced varieties as well as the numeraire. As expected, to this point all results are in line with those presented by Meltiz and Ottaviano.

This makes sense, as although this model lacks domestic production in *F*, the consumer utility remains fundamentally unchanged. Demand is not intrinsically impacted by the origin of the variety. Moving forward, the real departure from Melitz and Ottaviano stems from the addition of a fixed cost to export. This will drive a wedge between average prices in the two countries, and introduce complications to calculating the cost cutoffs as well as average prices.

1.3.2 Firm Behavior

For the purposes of this model, I assume that labor is the only factor of production. In addition, it is assumed that the labor market is competitive with workers supplying their time inelastically. The numeraire market operates under competitive conditions as well, where the numeraire good is produced under constant returns to scale and at unit cost. These assumptions allow for the simplifying assumption of a unit wage.

Firms that choose to enter into the differentiated market must incur a cost. Firms face a fixed cost of attempting to enter the market for varieties that can be thought of as research and development costs. Upon paying this fixed cost of entry (f_e), firms discover their marginal cost. Once they have paid f_e, firms produce under constant returns to scale at their given marginal cost. The marginal cost can be viewed as a labor unit requirement.

What distinguishes this genre of models is the nature of marginal costs. The development process yields uncertain outcomes for firms that choose to enter the differentiated market. Firms learn their marginal cost (c) only upon paying their irrecoverable development fee of f_e. Although firms are uncertain about their specific cost, they are aware of the common distribution of possibilities. In order to capture this phenomenon, I model the process as a random draw from a common, known distribution $G(c)$ on support $[0,\ c_{max}]$. In this paper it is assumed that the cost distribution is uniform. Thus the cumulative distribution is given as:

$$G(c_i) = \frac{c_i}{c_{max}}$$

where c_{max} represents the highest marginal cost any firm can face. Again, the sunk nature of the fixed entry cost comes into play. If firms can cover their marginal cost they produce. Any firm that can't recoup at least their marginal cost of producing exits the market. Due to trade costs, firms make this decision based on the domestic market in *H*.

In addition firms are profit maximizing. Thus firms deciding on whether to serve the exporting market face a potential profit from that market of:

$$\pi_x^H = q_i^F(p_i^F - (1+s)\tau c_{ix}^H) - f_x$$

Where c_{ix}^H gives the cost of the exporting firm in question, $s \geq 0$ represents trade costs faced by firms that export to the South, and $\tau \geq 1$ represents any tariff by the South. Following in the same spirit as Behrens et al, I structure tariffs as a specific tax. Increases in τ are tantamount to increases in an ad valorem tariff. f_x gives the fixed cost of setting up export operations.

Plugging in Equation 1-3 to the profit function and maximizing, gives the profit maximizing price and quantities:

$$q_i^F = \frac{(1-\theta)}{2\gamma}\left(\frac{\alpha\gamma}{\gamma+\eta N_x^H} + \frac{\eta}{(\gamma+\eta N_x^H)}\tilde{p}^F - (1+s)\tau c_x^H\right) \qquad (1\text{-}8)$$

$$p_i^F = \frac{1}{2}\left(\frac{\alpha\gamma}{\gamma+\eta N_x^H} + \frac{\eta}{(\gamma+\eta N_x^H)}\tilde{p}^F + (1+s)\tau c_x^H\right) \tag{1-9}$$

Plugging this back into the profit function yields equilibrium profits of:

$$\pi_x^H = \frac{(1-\theta)}{4\gamma}\left(\frac{\alpha\gamma}{\gamma+\eta N_x^H} + \frac{\eta}{(\gamma+\eta N_x^H)}\tilde{p}^F - (1+s)\tau c_{ix}^H\right)^2 - f_x \tag{1-10}$$

where firms will only choose to enter the market if $\pi_x^w \geq 0$. As one might expect, firms with lower costs set lower prices and sell greater quantities as well as earning higher profits.

Firms then face the decision of whether or not to export. In the first stage, firms decide whether they want to pay a fixed cost of entry, given total expected profits. These profits are split into two parts. Firms, upon learning their cost draw, may either serve only the domestic market, or pay an additional fee to sell to both the domestic and foreign markets. Firms that export face trade costs as well as any tariffs imposed by the South.

The second stage is the firms' decision on whether they want to serve the foreign market. This decision is made with full knowledge of the firm's marginal cost of production. Thus, given a firm has already paid the fixed entry cost, they then face economic profits from exporting as given in Equation 1-10. In order to solve for the zero profit conditions, I use backwards induction, starting with the firm's export decision. Solving Equation 1-1 for the marginal firm will yield the cost cut off of the marginal exporter. Note, that here the demand for the marginal exporter's variety is nontrivial. In addition, if fixed costs and tariffs are removed the condition collapses back to the Melitz-Ottaviano style of exporting profits.

Equation 1-10 gives the profit a firm derives from serving the export market, taking into account the fixed costs of setting up an export operation. The first area of interest is to see how these costs impact the cost cutoffs for firms that choose to export. Again it is important to note the differences relative to prior work: due to the introduction of fixed costs of export, a complication has been introduced to the problem. When the fixed cost is excluded, the cutoff for exporters takes the same distribution as domestic cost cutoffs. The cost of trade simply scales the cost cut off for exporting downward. With the introduction of f_x, a wedge has been driven between the domestic and exporting cost cutoffs.

In order to solve for the cost at which producers drop out of the export market, I take export profits and set them to equal to zero for the marginal firm:

$$\pi_x^H = \frac{(1-\theta)}{4\gamma}\left(\frac{\alpha\gamma}{\gamma+\eta N_x^H} + \frac{\eta}{(\gamma+\eta N_x^H)}\tilde{p}^F - (1+s)\tau\hat{c}_x^H\right)^2 - f_x = 0 \tag{1-11}$$

where $\hat{c}_x^H$ respresents the marginal cost that drives profits of exporting to zero. Clearly, any firm with $c \leq \hat{c}_x^H$ will enter the export market. Any firm with $c > \hat{c}_x^H$ does not service the export market. Solving equation 1-11 for the cost cut off is:

$$\hat{c}_x^H = \frac{1}{(1+s)\tau}\left[\frac{\alpha\gamma}{\gamma+\eta N_x^H} + \frac{\eta}{(\gamma+\eta N_x^H)}\tilde{p}^F - \left(\frac{4\gamma f_x}{1-\theta}\right)^{1/2}\right] \tag{1-12}$$

To clarify, this represents the marginal cost at which firms from *H* are indifferent between exporting to *F* and simply serving the domestic market. It is evident that increases in trade costs and tariffs, as well as increasing fixed costs of exporting drive down the cost cutoff. Increasing the market size of the South acts to increase the cost cutoff of exporting. These results match those that would be expected a priori. Solving for the consumer price index yields:

$$\tilde{p}^F = \frac{\int_0^{c_x^H} p^F dG(c)}{G(c_x^W)} = \frac{1}{2}\left(\frac{\alpha\gamma}{\gamma + \eta N_x^H} + \frac{\eta}{(\gamma + \eta N_x^H)}\tilde{p}^F + \frac{(1+s)\tau c_x^H}{2}\right)$$

so:

$$\tilde{p}^F = \frac{2\alpha\gamma + c_x^H(1+s)\tau(\gamma + \eta N_x^H)}{4\gamma - 2\eta + 4\eta N_x^H} \tag{1-13}$$

Next I turn to the domestic market equilibrium in the North. The problem for domestic producers is greatly simplified due to the lack of a fixed cost of exporting. As before, firms maximize their profit, but do not take the fixed entry cost into account because it is sunk. Thus the profit maximizing quantity must satisfy the condition:

$$q_i^H = \frac{\theta}{\gamma}(p_i^H - c)$$

Firms whose profit-maximizing price is greater than the maximum price cap simply exit the market. Further, the assumption is made that c_{max} is high enough that there exists at least some subset of firms that do not produce. These firms find that their marginal cost is such that their profit maximizing price would elicit zero demand. All firms with costs less than $\hat{c}^H$ (which represents the cost of the marginal firm that is indifferent between producing and exiting the market) will produce and earn positive economic profits. The results for *H* follow directly:

$$p^H = \frac{1}{2}(\hat{c}^H + c)$$

$$q^H = \frac{1}{2\gamma}(\hat{c}^H - c)$$

$$\pi^H = \frac{\theta}{4\gamma}(\hat{c}^H - c)^2$$

Next I utilize the zero demand condition to find the endogenous number of firms that survive in *H*. Firms pay their fixed cost of entry to find out their marginal cost. Although a subset of firms enters the exporting market, survival is driven through the domestic market. This is clear when I take into account that preferences are identical across countries, while exporters face more barriers in the form of trade costs, tariffs, and export set up fees. Thus I look to the domestic zero demand condition to determine the equilibrium number of firms that survive after discovering their marginal cost. Equation 1-6 gives the maximum price that firms can charge in the domestic market. Note that the final term $\eta N^{H}\tilde{p}^{H}$ stems from the fact that dividing $\tilde{p}^{H}$ by the number of firms yields the average price. In addition, firms will stay in the market as long as they can cover their marginal cost. Thus the marginal firm is the firm whose marginal cost is exactly equal to the price that drives demand to zero. Thus, it is true that $p_{max} = \hat{c}_x^H$. I can then use the above equation to solve for the equilibrium number of firms:

$$N^{H} = \frac{4\gamma}{\eta}\left(\frac{\alpha-\hat{c}^{H}}{\hat{c}^{H}}\right) \tag{1-14}$$

Finally, to complete the conditions of the model, I use the free entry condition to find the endogenous cost at which producers are indifferent between supplying for the domestic market or exiting. It is evident that firms will enter the market until the point in which their gross total profits from the domestic market, when added to the net profits accounting for fixed costs of exporting, are equal to the fixed entry fee. This condition can be written as:

$$\int_0^{\hat{c}^H} \pi_D^H dG(c) + \int_0^{\hat{c}_x^H} (\pi_x^H - f_x) dG(c) = f_e$$

It's possible to rewrite this:

$$\int_0^{c^H} \pi_D^H dG(c) + \int_0^{c_x^H} (\pi_x^H - f_x) dG(c)$$

$$= \frac{\theta}{4\gamma}\int_0^{\hat{c}^H} (\hat{c}^H - c)^2 dG(c) + \frac{(1-\theta)}{4\gamma}\int_0^{c_x^H} \left(\frac{\alpha\gamma}{\gamma+\eta N_x^H} + \frac{\eta}{(\gamma+\eta N_x^H)}\tilde{p}^F - (1+s)\tau\hat{c}_x^H\right)^2 dG(c) - f_x = f_e$$

This equation yields the cost cutoff $\hat{c}^H$ of the surviving firms:

$$\hat{c}^H = \left[\frac{1}{\theta}\left((12\gamma f_e c_{max}) - \frac{(1-\theta)}{(1+s)\tau}\left(\left(\frac{\alpha\gamma}{\gamma+\eta N_x^H} + \frac{\eta}{(\gamma+\eta N_x^H)}\tilde{p}^F\right)^3 - \left(\frac{\alpha\gamma}{\gamma+\eta N_x^H} + \frac{\eta}{(\gamma+\eta N_x^H)}\tilde{p}^F - (1+s)\tau\hat{c}_x^H\right)^3\right)\right)\right]^{1/3} \quad (1\text{-}15)$$

The only exercise left is to find the number of firms that serve the export market. This is simply given by $N_x^H = G(\hat{c}_x^H)N^H$. This yields:

$$N_X^H = N_D^H \frac{\hat{c}_x^H}{c_{max}} \quad (1\text{-}16)$$

These equations fully define the world economy. All that remains is to find the unique equilibrium found through the system of equations given by Equations 1-12 through 1-16. The range of costs is displayed graphically in Figure 1-1. The most efficient firms will serve both of the markets, the firms with moderate fixed costs serve only their domestic market, and the least efficient firms simply shut down.

Unfortunately, this closed form system of equations involves a nonlinear set of equations that defy analytical solutions. Much like Romer, this model is unable to provide a neat mathematical statement. Instead of a purely theoretical solution, I must rely on the power of simulations to model the results of changes in tariffs and exporting fixed costs in regards to how they impact consumer welfare in *F*. When fixed exporting costs are introduced, they drive a wedge between the distribution of costs in *H* and *F*, which greatly complicates the calculations in solving for the equilibrium. Section 1.4 will present the methodology as well as results from the simulations.

1.4 Simulations

1.4.1 Methodology

After developing the analytical framework, I turn to simulations to test the results where fixed costs are included. The goal throughout is to test the reactions of a wide array of world economies to changes in trade policy.

The confounding aspect of this model is the addition of f_x. This alone drives a majority of the issues in trying to solve for equilibrium values. The reason for this is fairly straightforward. In the absence of these fixed costs of exporting, the model is much more tractable. The price received by exporting firms is scaled down by the costs of trade (in this case the tariff). When fixed exporting costs are added, another wedge is driven between the domestic price in the South and the price received by firms located in the rest of the world. This is simple to see by examining the export decision. In this version of the model, firms will export only if they can cover their fixed costs by doing so. In the absence of the fixed costs, a firm will export as long as it can cover its marginal cost of exporting. Although that marginal cost now includes trade costs, it means that the marginal firm is actually determined through a zero demand condition. Thus the maximum cost exporter in the no exporting fixed costs world is given as:

$$\hat{c}_x^w = \frac{\hat{c}^w}{s}$$

This implies that all domestic results still hold, simply scaled back. The complication lies in the fact that the marginal firm is no longer the firm that faces zero demand. Instead there is a subset of firms that have positive demand but fail to export due to negative profits.

Although this is somewhat limiting, by examining a wide range of potential economic settings, a robust picture of welfare is developed. In addition, this is in the same style as Romer.

As in Romer, the primary focus in this paper is the interaction between fixed export costs and tariffs. By solving for welfare of the South, it is possible to analyze the welfare effects of this interaction. Aside from the numeraire, welfare relies on exports as foreign firms provide their entire consumption of the differentiated good. Plugging in equilibrium values to Equation 1-7 yields the explicit welfare function:

$$W = 1 + \frac{1}{2}\left(\eta + \frac{\gamma}{N_X^W}\right)^{-1}(\alpha - p^F)^2 + \frac{1}{2\gamma}\left(\left(\frac{\alpha\gamma}{\gamma + \eta N_x^W} + \frac{\eta}{(\gamma + \eta N_x^W)}\tilde{p}^F + (1+s)\tau\hat{c}_x^W\right)\frac{\hat{c}_x^W}{c_{max}} - p^F\right)^2$$

where the number of exporting firms, the consumer price index, and the cost cutoff are all determined endogenously through the system of equations.

Given the aim of this paper, I focus on two key issues. Romer hypothesized that most economists do not place enough emphasis on the fact that barriers to trade not only increase price, but also completely remove potential varieties from the market. The goal is to analyze the impact of a tariff in two different settings. The first is a world where there are no institutional barriers to export. The second is an economy in which fixed costs of exporting are positive.

As touched upon earlier, the introduction of f_e introduces a new wrinkle into any trade model. If fixed costs are absent, then the decision to export is made solely on whether the potential exporter can recover its marginal production and trade costs. As long as firms can do so, they choose to export the good. When fixed costs of exporting are introduced this adds a new cost that firms must consider when addressing the decision to export.

The natural scenario to examine first is the situation in which $f_x = 0$. In this case the marginal firm (that is the firm that is indifferent between exporting or not) must set a price that will cover the combination of its marginal production and trade costs. For this marginal firm, previous work shows that the price it charges is a price that drives demand to zero, and thus puts it on the margin. Any firm with a cost lower than the marginal firm sets a lower price and thus garners some demand, while still earning a profit. The key to this analysis is that as a tariff increases there is an additional effect in terms of firm exit.

When f_x is greater than zero, ex ante, it is not clear what the welfare results of a tariff should be. One might assume that the introduction of fixed exporting costs would push out the least efficient firms, leaving only the most competitive firms capable of covering the new fixed export costs. If this were the case, then it seems logical that a tariff would have a negligible effect, since only the more efficient firms remain. On the other hand, it may be the case that the pressure caused by increased trade costs (transport, tariff and fixed) erode firm entry slowly at first, and become stronger as tariffs rise. The intuition for this second argument seems more tenuous. In essence, this paper seeks to determine the sign on the following second derivative:

$$\frac{\delta^2 W}{\delta f_x \delta \tau} \gtreqless 0$$

If the sign on this term is positive then it implies that as the fixed cost increases, the impact of a tariff also increases. This will be true if the first hypothesis is correct. If, instead, the sign is negative, then the implication is that introducing fixed costs of exporting dampens the impact of tariffs on welfare.

It is important to note a major difference between the analysis conducted by Romer and the one presented in this paper. Although Romer places a major emphasis on the role of fixed costs as a determinant of his “missing goods,” the model he presents does not rely on fixed exporting costs, but rather on an endogenous number of firms to drive the results.

While the number of firms is certainly related to fixed costs (as previously demonstrated) that does not mean that they are interchangeable. The welfare analysis he conducts centers around the number of firms that choose to export. When looking at Romer’s work it is more appropriate to distinguish, not between the presence and absence of fixed exporting costs, but rather long run versus short run entry decisions.

The first scenario that Romer contemplates is one in which, when accounting for predetermined fixed exporting costs, the number of firms does not vary with the introduction of a tariff. This occurs because firms make their entry decisions assuming that the tariff rate is zero and pay their set up cost. An introduction of a tariff does not impact the number of firms as each firm has already paid an export fee. At this point the export fee acts as a sunk cost. For ease, one might think of this as a short run solution to the problem, as there are sunk costs.

The second scenario involves looking at welfare effects if potential exporters expect the tariff. In this case, firms will consider the tariff when making their export decision. The key to understanding his analysis is that, here, firms are homogeneous across marginal costs and heterogeneous across fixed export costs. Thus, once a decision is made to export, all exporters will face the same short run consequences of a tariff. When the tariff is expected, a subset of potential exporters forgoes serving the foreign market because they cannot cover their unique fixed cost. Thus the expected tariff directly reduces the number of exporters.

So although Romer emphasizes the role of fixed costs (and they do matter), the real emphasis in his work winds up being the difference between the long run and short run. The fixed costs are in place to introduce the removal of goods from the market, without specific attention to welfare effects from the fixed costs themselves. In this paper an attempt is made to strike more directly at the heart of matter. So, while this paper will also examine the short run versus long run effects of a tariff, it also examines the effects of positive fixed exporting costs versus zero fixed exporting costs, and how that difference changes the effects of a tariff.

First, the focus is placed on welfare changes when the number of firms is allowed to vary. This is analogous to a long run world in that firms respond to a tariff by changing their export decision. One can think of this as if the decision to pay the fixed cost of exporting is made with full knowledge of any potential tariffs. The second scenario is one in which the number of firms is fixed. This is much like a short run scenario in which firms have already paid the export set up fee and thus do not respond to changes in a tariff since some costs are already sunk.

In order to look more specifically at the role fixed exporting costs play, I run two rounds of simulations. The first looks at welfare changes when f_x is equal to zero with incremental increases in the tariff. This yields a percent change in welfare for each tariff level. The second simulation takes a baseline measure of welfare when the tariff is zero but $f_x > 0$. By comparing the baseline to similar simulations where the tariff is positive, it is possible to examine the interaction between tariffs and institutional barriers to trade.

1.4.2 Simulation Technique

Although pen and paper calculations fail in solving this system of equations, simulations allow an in depth analysis of the tariff/f_x interaction. By considering a wide range of possible economic scenarios it is possible to provide useful insight into the behavior of this model.

Recall that α, γ, and η are all demand parameters. The levels of α and η give the level of demand for the differentiated good as compared to the numeraire. The initial step is to focus on parameter values that guarantee non-negative demand. In addition, γ gives the degree of product differentiation present in the varied market. At the limit $\gamma = 0$, utility is independent of variation and relies merely on consumption summed over all goods. Thus it is important to choose a parameter value that distributes consumption over varieties.[4]

Next, I turn my attention to the parameters that define the world economy. The first parameter under examination is θ. This represents the relative size of the South in relation to the rest of the world. The initial specification is $\theta = 0.5$. Although an unreasonable assumption in the context of the model, it turns out that the relative market size does not play a large role in welfare effects. This is due to the fact that welfare depends on the number of firms, not the size of the markets. Although cost cutoffs depend on the market size to some extent, they play only a minimal role. Of

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[4] Demand parameters are given values of $\alpha = 2$, $\eta = 0.2$, and $\gamma = 0.05$. These values stem from earlier work as well as guaranteeing positive demand for varieties at equilibrium. For further discussion of parameter values please see Behrens et al. (2007) and Behrens et al. (2009). Though these values are chosen to model European VAT's, it serves as a good starting point. All results are robust across a variety of specifications as shown in the results.

greater importance is the number of firms exporting. So although I do test against a range of market size, I find that the results are robust against all specifications.

Secondly I address the range of costs present in market. This is determined by the parameter c_{max}. From Equation 1-6, it can be seen that the highest p_{max} must be less than the parameter value given for α. This places an upper bound on the value of the c_{max}. In the range $[0,\ \alpha]$ for c_{max} the results are also robust. When c_{max} rises high enough above α, the results become irrational. It can be seen that for $c_{max} > \alpha$ there is an increasing probability that the model will violate the binding constraint that price is less than α. At a certain point, price will raise above α, leading to the boundary solution of zero demand. Thus, the analysis is limited to $c_{max} < \alpha$.[5] Note that c_{max} is not vital in the range discussed. Although it does have an effect on the resulting cost cutoffs, c_{max} acts as a scaling variable. The cost cutoffs rise with c_{max} but the end result in terms of welfare remains the same.

The last parameters left to define are those for the fixed costs. There are two fixed costs that impact the performance of the model. The first is the fixed cost of discovering the firms' marginal cost. The second is the fixed cost of exporting. The fixed cost of entry is less important. Although it plays a role in determining the domestic cutoffs, it plays a minimal role in the welfare of the South. With lower fixed entry costs, more firms will enter and supply the South with imports. Allowing fixed entry costs to vary does not meaningfully impact the results.[6] The more interesting variable in this

[5] The working specification for c_{max} is 1. Although other results are omitted, the results hold for the entire range of $c_{max} \in [0,\ \alpha\ ]$.

[6] Fixed entry costs are set equal to 1. Although other specifications were simulated, the results remain the same.

regard is the fixed cost of importing. Indeed, this might be the single most important variable in the entire analysis. This study is interested in the impact of tariffs in different regimes; regimes that depends on the level of the fixed cost of exporting. In order to fully explore the interaction, a range of fixed exporting costs is analyzed.[7]

1.5 Results

Through these simulations, an attempt is made to examine the role fixed exporting costs play on welfare as tariffs vary. A priori, it is unclear how the interaction between tariffs and fixed costs of export will impact consumer welfare. If Romer's results hold, fixed costs will hurt welfare. On the other hand, if efficiency matters, then fixed costs will serve to eliminate inefficiencies and to dampen the impact of tariffs.

With no analytical solution, it is necessary to turn to the simulation results. The first results presented are the welfare changes as the fixed cost of entry (f_e) changes. Table 1-1 presents the results from this simulation. Figure 1-2 plots welfare changes with respect to a tariff for the scenario in which fixed costs of entry are equal to 1. Figure 1-3 plots results of the tariff's impact on welfare while allowing the fixed cost of entry to vary as well.

In addition, ceteris paribus, an increase in the fixed cost of entry increases the damage inflicted upon consumers by a tariff. That is:

$$\frac{\delta^2 W}{\delta f_e \delta \tau} > 0$$

Returning to Equation 1-15, it is evident that as fixed entry costs increase, the domestic cost cutoff increases. This not only impacts the domestic market, it also

[7] Fixed costs are allowed to vary in the range $[0, 1]$ on increments of 0.1. It seems reasonable to assume that fixed exporting costs will be less than the fixed cost of research and development so the range of fixed costs of exports is similar.

increases the number of firms serving the exporting market (as can be seen from Equation 1-14). It seems that when there are more firms present, the impact of a tariff is greater, as it removes more potential exporters from the market. Although competition is increased, in the baseline zero tariff regime consumers lose out on more varieties as firms increase their exports. In addition, it is evident that increases in the fixed cost of entry increase welfare in the South. Turning to the cost cutoff for domestic production, an increase in f_e increases the domestic cost cutoff, which decreases the number of surviving firms. This effect results in an decrease in the number of exporters, thus decreasing welfare.

Next attention is focused on the short run effects of a tariff. For this scenario, the number of exporting firms is fixed. Thus, the only effect of a tariff is through higher average prices and cost cutoffs. The simulation looks at welfare changes over a range of fixed exporting costs. Results are presented in Table 1-2.

As can been seen in Table 1-2, for any given level of fixed costs of exporting, an increase in the tariff decreases consumer welfare. This is to be expected, as an increase in the tariff decreases the cost cutoff for exporters as well as increases the average price. Both of these harm consumers. In addition, it is clear that increases in the fixed cost of exporting hurt the overall welfare level.[8] The increase in fixed cost of exporting forces exporters from the market, decreasing the number of varieties avaliable to consumers. It is also apparent that compared to the zero fixed cost of exporting scenario, the addition of f_x decreases the impact of trade policy on welfare.

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[8] Welfare level is given in parentheses below the value of the fixed cost. These numbers are calculated by looking at the welfare level of an economy with the fixed cost of exporting but zero tariff.

Shifting focus, I next turn to a long run equilibrium, where firms are aware of tariffs when making their entry to exporting decision. Here the equilibrium number of exporters does vary with the tariff, as firms are aware of the impending tariff before they commit to paying f_x. It seems likely that the results from the short run and long run will show the same pattern as Romer. When the number of firms does not vary with a tariff (the short run), the only effect of the tariff is through cost cutoffs and the price index. The only change in the long run is that the number of firms decreases with the tariff. It makes sense that fewer firms implies larger welfare losses. Table 1-3 presents the long run results from the simulation.

Table 1-3 displays the results when the fixed exporting costs, the tariff, and the number of exporters are allowed to vary. These results are then compared to a zero tariff setting. As expected, allowing the number of exporters to change, increases the impact of the tariff on consumer welfare. However, the results here are much smaller in magnitude than those presented by Romer. In his work, a 10% tariff in the short run causes a loss to consumers of roughly 1% (where as this paper finds a welfare loss of roughly 1.77%), while a 10% tariff in the long run causes losses in welfare of 19.81%. Obviously the findings here show a much more modest impact on welfare with losses in the long run of only 5.17%.

Also evident in Table 1-3, the introduction of fixed exporting costs continues to mitigate the impact of tariffs. Although overall welfare is lower, the percentage of welfare lost as a result of the tariff is strictly less for every specification simulated. This is an unambiguous result that directly contradicts some of the claims issued by Romer.

Figure 1-4 graphically demonstrates the relationship between welfare, the fixed costs of exporting and a tariff. When the tariff is introduced, ceretis parabis, welfare falls by a smaller amount as the institutional barriers to trade grow. Again, the belief is that this stems from the nature of welfare in the model. Welfare depends heavily upon the number of varieties that consumers have access to. Welfare is reduced by anything that acts to decrease the number of firms that serve the South. Both fixed costs of exporting and the tariff, individually, decrease the number of firms that sell in the South.

Table 1-4 gives the resulting number of exporters from each f_x/tariff combination. All else being held constant, when either the fixed cost of exporting or the tariff increases, the result is a decrease in the number of firms that choose to serve the South.

As Tables 1-3 and 1-4 and Figure 1-4 show, when fixed costs of exporting are imposed, ceretis parabis, welfare falls by less with the addition of a tariff than when fixed costs of exporting are absent. Again, this stems from the nature of welfare in the model. Welfare depends heavily upon the number of varities to which consumers have access. Welfare is reduced by anything that decreases the number of firms that serve the South. Both fixed costs of exporting and the tariff, individually, decrease the number of firms that sell in the South. However, when fixed costs of exporting are imposed, they seem to play a larger role in eliminating importing varieties. Thus, contrary to the ideas posited by Romer, in this model it is the case that:

$$\frac{\delta^2 W}{\delta f_x \delta \tau} < 0$$

Table 1-1 does yield some additional results of interest. For any given tariff level, as fixed costs increase the impact on welfare is decreasing. As f_e continues to rise, the welfare loss from a tariff rises at a decreasing rate. The difficultly in solving the model analytically was the non-linearity of the cost functions. The same is true with the fixed costs. Due to the non-linear nature of the system of equations, as the levels of fixed cost vary the direction of change does vary. However, regardless of the level of fixed cost of exporting, the results of a tariff are always less in their presence than in their absence.[9]

Both Tables 1-2 and 1-3 give results from the baseline simulations. I do look at the impact of allowing some of the parameter values to vary. Perhaps the most obvious parameter to look at is θ. The baseline sets $\theta = 0.5$. This is obviously not in line with the assumptions in the model. A la Romer, I seek to model a world economy that is the sole provider of a differentiated good to a South. The relative magnitude of the world economy should be fairly large given this assumption.

The results are tested against various level of θ in the range of [0.5, 0.9]. The results from Table 1-1 and 1-2 hold across the entire range. This makes sense as for the purposes of this model, θ acts mainly as a scaling variable. Increasing theta simply diminishes the demand from the South. This does impact firm decisions to some extent, but fundamentally does nothing to alter the effects of f_x. Tables 1-5 and 1-6 show a sampling of these simulations.

The same pattern holds for all three values of θ displayed. As fixed costs of exporting grow, the addition of a tariff has a smaller impact on consumer welfare. When θ grows, this implies a smaller population in *F*. As one might expect, the baseline

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[9] For the sake of rigor f_x is tested in the entire range between 0.01 and 3. Although it does not make intuitive sense for the fixed exporting cost to be greater than the fixed cost of entry, the results are valid for the entire range.

impact of trade policy declines when the population in *F* decreases. This stems from the fact that exporting is less important to firms when θ is large, thus additional trade costs matter less as there are fewer firms exporting.

Similarly, a range of values for c_{max} are considered. As with fixed exporting costs, c_{max} does not play a vital role in determining welfare. As c_{max} increases, more firms enter both markets, but the way fixed costs behave is unaltered. Thus for any $c_{max} < \alpha$ the result, that fixed cost of exporting dampens the impact of a tariff, is robust.

The third variable that is important is γ. Recall that γ indexes the emphasis consumers place on the degree of product differentiation. It may be the case that a low value of γ is driving the results. If γ is artifically low, then consumers care less about variety and more about overall consumption. In this case, the loss of variety would have a small impact on welfare, and possibly provide a false result in the simulation.

Although less vital, in Table 1-7 a range of values for α and η are also examined. Throughout all of the specifications, the result that adding a fixed cost of exporting decreases the welfare losses from a tariff holds. Table 1-8 gives a sample of results from varying α.

Ceteris paribus, it is apparent that the fixed exporting cost serves to dampen the impact of a tariff. It is interesting to note that as α increases, the two regimes converge. Prehaps most surpisingly, an increase in α actually lessens the impact of a tariff. This is unexpected, as α indexs the demand for variety relative to the numeraire, thus increasing the demand for the differentiated product. This most likely occurs because as α increases, so too does the cost cutoff of exporters. This means that more firms serve the export market before a tariff is imposed. In addition, turning to Equation 1-12, increasing α relative to the tariff effectively diminishes the importance the tariff plays in determining the cost cutoff. Regardless, the more germane result is that across all specifications, the same effect persists: fixed costs diminish the role tariffs play in decreasing welfare.

Finally, the results are tested against different tariff ranges. Although a 10% tariff was the standard used by Romer, I test the results against tariffs running from 0.1%-1% as well as the range of 10%-50%. Results from these simulations are presented in Tables 1-9 and 1-10. Again, as the fixed costs of exporting increase the same trend persists.

1.6 Conclusions

There are two main conclusions that can be drawn from these simulations. First and foremost, when fixed costs of exporting are examined specifically, it can be shown that these additional fixed costs actually decrease the impact of a tariff on consumer welfare. Secondly, the tractibility of the model with quasi-linear demand developed by Meltiz (2003)[10] declines greatly with the addition of confounding parameters.

To reiterate, this study focuses on an issue that is a substantially different from Romer. Upon re-examination, Romer's final analysis seems to address a question unrelated to the main thrust of his presentation. Although my paper does look at the short run versus long run equilibrium, unsurprisingly the results are the same. However, the bulk of Romer's paper focuses on the fact that economists often ignore the role fixed

[10] Although substantially altered, the model retains many of the characteristics of the model that Melitz pioneered which illustrated the fact that only the most efficient firms enter the export market. One of the key differences is the model does not allow for a probability of firm death.

exporting costs play in determining the number of goods traded. While this may or may not be true, his final model presented also fails to deal with this issue directly.

By differentiating firms along the measure of fixed cost of exporting, I find some interesting economic side effects. Since all firms have the same marginal cost of production, if the fixed cost of exporting is set equal to zero for all firms, tariffs will have a very discontinuous impact. All firms will continue to serve the South for any tariff that still allows them to recover their marginal cost (again this is the same across all firms). Initial increases in the tariff will have no impact on the number of exporting firms. As all firms face the same marginal costs, they will all continue to export. However, at some level the tariff will make exporting economically unviable. At that distinct tariff, every firm will cease to exporting, completely eliminating the export market. As a result, when there are no fixed costs to exporti, this model predicts only two values for the number of exporters. Either the tariff will be low enough that every firm will serve the foreign market, or the tariff will be prohibitively high, leaving no firms in the export market. Thus in the absence of fixed exporting costs, the model only has two values for the number of exporters: the entire population of potential exporters or no exporters.

Since Romer includes a heterogeneous fixed costs of exporting, there is no discrete welfare jump. In essence, Romer compares welfare of a country that imposes a tariff when the number of foreign firms is fixed to when the number of firms is allowed to vary. It is thus unsurprising that Romer finds that when the number of firms are allowed to vary, national welfare declines. It is a fairly well estabilished belief that consumers are better off with more varieties. Therefore the finding, that allowing the number of firms to vary decreases national income by 18% more than when the number of firms is fixed, is a simple confirmation of long held economic beliefs.

This analysis looks more specifically at the role that fixed exporting costs play in determinating consumer welfare. By allowing the number of firms to vary under both regimes, the focus is solely on the effect caused by these additional fixed costs. It can be shown that under all rational specifications, the addition of fixed costs of exporting actually dampens the impact of a tariff. This finding stems from the fact that fixed costs of exporting prohibit the least efficient firms from exporting. Thus, the tariff plays a smaller role in removing exporting firms from the market.

Finally, it is useful to note that this work has illuminated some limitations in the model as presented in Melitz and in Melitz and Ottaviano. Although this style of model has gained popularity in recent years, its predictions concerning which firms export do have limitations. When trade is introduced to the model, clear solutions stem from the nature of cost distributions. Tariffs do not change the distrubution for costs of exporters, and the zero demand conditions remain in place. However, with the introduction of fixed costs, a wedge is driven between zero demand and zero profit for firms that export. This means that the export decision no longer relates to the marginal firm that faces zero demand. Instead, the marginal firm is predicated based upon zero profit. This means that average prices also become much more convoluted. For trade economists, it is important to realize the sensitive nature of the model, and thus its limitations for practical application.

Table 1-1. Welfare effects of fixed entry costs and tariffs

Fixed Costs of Entry	Tariff									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
1.0 (6.54)	-0.70%	-1.38%	-2.06%	-2.74%	-3.40%	-4.06%	-4.71%	-5.36%	-6.00%	-6.63%
1.1 (6.85)	-0.73%	-1.46%	-2.18%	-2.89%	-3.59%	-4.29%	-4.98%	-5.66%	-6.34%	-7.00%
1.2 (7.22)	-0.77%	-1.52%	-2.28%	-3.02%	-3.75%	-4.48%	-5.20%	-5.92%	-6.62%	-7.32%
1.3 (7.66)	-0.79%	-1.58%	-2.36%	-3.13%	-3.89%	-4.64%	-5.39%	-6.13%	-6.86%	-7.58%
1.4 (8.15)	-0.82%	-1.62%	-2.42%	-3.21%	-4.00%	-4.77%	-5.54%	-6.30%	-7.05%	-7.80%
1.5 (8.70)	-0.83%	-1.66%	-2.47%	-3.28%	-4.08%	-4.88%	-5.66%	-6.44%	-7.21%	-7.97%
1.6 (9.31)	-0.85%	-1.68%	-2.51%	-3.34%	-4.15%	-4.96%	-5.75%	-6.55%	-7.33%	-8.10%
1.7 (9.98)	-0.86%	-1.71%	-2.55%	-3.38%	-4.20%	-5.02%	-5.83%	-6.63%	-7.42%	-8.21%
1.8 (10.71)	-0.86%	-1.72%	-2.57%	-3.41%	-4.24%	-5.07%	-5.88%	-6.69%	-7.49%	-8.28%
1.9 (11.49)	-0.87%	-1.73%	-2.59%	-3.43%	-4.27%	-5.10%	-5.92%	-6.74%	-7.54%	-8.34%
2.0 (12.33)	-0.87%	-1.74%	-2.60%	-3.45%	-4.29%	-5.12%	-5.95%	-6.77%	-7.58%	-8.38%

The table presents the percent change in welfare that results from a tariff of specified size when there are no fixed exporting costs. Numbers in parentheses represent the absolute value for welfare in the South in the absence of a tariff. Parameter values for the analysis are: $\alpha = 2$, $\eta = 0.2$, $\gamma = 0.05$, $c_{max} = 1$, $f_x = 0$, and $\theta = 0.5$

Table 1-2. Welfare effects of fixed export costs with a fixed number of firms

Fixed Costs of Exporting	Tariff									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
0.1 (6.54)	-0.54%	-1.08%	-1.61%	-2.14%	-2.66%	-3.17%	-3.68%	-4.19%	-4.68%	-5.17%
0.2 (5.36)	-0.47%	-0.94%	-1.41%	-1.86%	-2.32%	-2.76%	-3.20%	-3.64%	-4.07%	-4.50%
0.3 (5.07)	-0.42%	-0.83%	-1.24%	-1.65%	-2.05%	-2.44%	-2.83%	-3.22%	-3.60%	-3.98%
0.4 (4.92)	-0.37%	-0.74%	-1.11%	-1.47%	-1.82%	-2.18%	-2.52%	-2.86%	-3.20%	-3.54%
0.5 (4.83)	-0.33%	-0.66%	-0.99%	-1.31%	-1.63%	-1.94%	-2.25%	-2.56%	-2.86%	-3.16%
0.6 (4.77)	-0.30%	-0.59%	-0.89%	-1.17%	-1.46%	-1.74%	-2.01%	-2.29%	-2.55%	-2.82%
0.7 (4.74)	-0.27%	-0.53%	-0.79%	-1.05%	-1.30%	-1.55%	-1.80%	-2.04%	-2.28%	-2.52%
0.8 (4.72)	-0.24%	-0.48%	-0.71%	-0.94%	-1.16%	-1.39%	-1.61%	-1.82%	-2.03%	-2.24%
0.9 (4.71)	-0.21%	-0.42%	-0.63%	-0.84%	-1.04%	-1.23%	-1.43%	-1.62%	-1.81%	-2.00%
1.0 (4.71)	-0.19%	-0.38%	-0.56%	-0.74%	-0.92%	-1.10%	-1.27%	-1.44%	-1.60%	-1.77%

The table presents the percent change in welfare that results from a tariff of specified size when the number of exporters is independent of the tariff. Numbers in parentheses represent the absolute value for welfare in the South in the absence of a tariff. Parameter values for the analysis are: $\alpha = 2$, $\eta = 0.2$, $\gamma = 0.05$, $c_{max} = 1$, $f_e = 1$, and $\theta = 0.5$

Table 1-3. Welfare effects of fixed export costs with a varying number of firms

Fixed Costs of Exporting	Tariff									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
0.0 (6.54)	-0.61%	-1.22%	-1.81%	-2.39%	-2.97%	-3.53%	-4.08%	-4.63%	-5.17%	-5.70%
0.1 (6.54)	-0.54%	-1.06%	-1.58%	-2.09%	-2.60%	-3.09%	-3.58%	-4.06%	-4.53%	-4.99%
0.2 (5.36)	-0.51%	-1.00%	-1.49%	-1.97%	-2.45%	-2.91%	-3.37%	-3.82%	-4.27%	-4.70%
0.3 (5.07)	-0.48%	-0.96%	-1.42%	-1.88%	-2.34%	-2.78%	-3.22%	-3.65%	-4.07%	-4.49%
0.4 (4.92)	-0.46%	-0.92%	-1.37%	-1.81%	-2.24%	-2.67%	-3.09%	-3.50%	-3.91%	-4.31%
0.5 (4.83)	-0.45%	-0.89%	-1.32%	-1.74%	-2.16%	-2.57%	-2.98%	-3.38%	-3.77%	-4.15%
0.6 (4.77)	-0.43%	-0.86%	-1.27%	-1.69%	-2.09%	-2.49%	-2.88%	-3.26%	-3.64%	-4.01%
0.7 (4.74)	-0.42%	-0.83%	-1.23%	-1.63%	-2.02%	-2.41%	-2.79%	-3.16%	-3.53%	-3.89%
0.8 (4.72)	-0.41%	-0.81%	-1.20%	-1.58%	-1.96%	-2.34%	-2.71%	-3.07%	-3.42%	-3.77%
0.9 (4.71)	-0.39%	-0.78%	-1.16%	-1.54%	-1.91%	-2.27%	-2.63%	-2.98%	-3.33%	-3.67%
1.0 (4.71)	-0.38%	-0.76%	-1.13%	-1.50%	-1.86%	-2.21%	-2.56%	-2.90%	-3.24%	-3.57%

The table presents the percent change in welfare that results from a tariff of specified size when the number of exporters varies with the tariff. Numbers in parentheses represent the absolute value for welfare in the South in the absence of a tariff. Parameter values for the analysis are: $\alpha = 2$, $\eta = 0.2$, $\gamma = 0.05$, $c_{max} = 1$, $f_e = 1$, and $\theta = 0.5$

Table 1-4. Impact of fixed export costs and tariffs on number of firms

Fixed Costs of Exporting	Tariff									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
0.1 (6.54)	1.320	1.315	1.310	1.305	1.301	1.296	1.292	1.287	1.283	1.278
0.2 (5.36)	1.279	1.275	1.270	1.266	1.261	1.257	1.252	1.248	1.244	1.240
0.3 (5.07)	1.243	1.239	1.234	1.230	1.226	1.221	1.217	1.213	1.209	1.205
0.4 (4.92)	1.210	1.206	1.202	1.198	1.193	1.189	1.185	1.181	1.178	1.174
0.5 (4.83)	1.180	1.176	1.172	1.168	1.164	1.160	1.156	1.153	1.149	1.145
0.6 (4.77)	1.153	1.149	1.145	1.141	1.137	1.133	1.130	1.126	1.122	1.119
0.7 (4.74)	1.127	1.123	1.120	1.116	1.112	1.109	1.105	1.101	1.098	1.095
0.8 (4.72)	1.104	1.100	1.096	1.093	1.089	1.086	1.082	1.079	1.075	1.072
0.9 (4.71)	1.082	1.078	1.075	1.071	1.068	1.064	1.061	1.058	1.055	1.051
1.0 (4.71)	1.062	1.058	1.055	1.051	1.048	1.045	1.041	1.038	1.035	1.032

The table presents the number of firms that serve the South when the number of exporters varies with the tariff. Numbers in parentheses represent the absolute value for welfare in the South in the absence of a tariff. Parameter values for the analysis are: $\alpha = 2$, $\eta = 0.2$, $\gamma = 0.05$, $c_{max} = 1$, $f_e = 1$, and $\theta = 0.5$

Table 1-5. Welfare effects of fixed export costs with a varying number of firms when theta= 0.75

Fixed Costs of Exporting	Tariff									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
0 (16.86)	-0.60%	-1.19%	-1.78%	-2.37%	-2.95%	-3.52%	-4.09%	-4.66%	-5.23%	-5.79%
0.1 (13.31)	-0.51%	-1.02%	-1.53%	-2.03%	-2.53%	-3.03%	-3.52%	-4.00%	-4.48%	-4.96%
0.2 (12.01)	-0.46%	-0.92%	-1.37%	-1.82%	-2.27%	-2.71%	-3.15%	-3.59%	-4.02%	-4.45%
0.3 (11.08)	-0.41%	-0.83%	-1.23%	-1.64%	-2.04%	-2.43%	-2.82%	-3.21%	-3.60%	-3.98%
0.4 (10.34)	-0.37%	-0.74%	-1.10%	-1.46%	-1.81%	-2.17%	-2.52%	-2.86%	-3.20%	-3.54%
0.5 (9.73)	-0.33%	-0.65%	-0.97%	-1.29%	-1.61%	-1.92%	-2.23%	-2.53%	-2.83%	-3.13%
0.6 (9.20)	-0.29%	-0.57%	-0.86%	-1.14%	-1.41%	-1.69%	-1.96%	-2.22%	-2.49%	-2.75%
0.7 (8.73)	-0.25%	-0.50%	-0.75%	-0.99%	-1.23%	-1.47%	-1.70%	-1.93%	-2.16%	-2.39%
0.8 (8.32)	-0.22%	-0.43%	-0.64%	-0.85%	-1.06%	-1.26%	-1.46%	-1.66%	-1.86%	-2.05%
0.9 (7.95)	-0.19%	-0.37%	-0.55%	-0.72%	-0.90%	-1.07%	-1.24%	-1.41%	-1.57%	-1.73%
1.0 (7.61)	-0.16%	-0.31%	-0.46%	-0.61%	-0.75%	-0.89%	-1.03%	-1.17%	-1.31%	-1.44%

The table presents the percent change in welfare that results from a tariff of specified size when the number of exporters varies with the tariff. Numbers in parentheses represent the absolute value for welfare in the South in the absence of a tariff. Parameter values for the analysis are: $\alpha = 2$, $\eta = 0.2$, $\gamma = 0.05$, $c_{max} = 1$, $f_e = 1$, and $\theta = 0.75$

Table 1-6. Welfare effects of fixed export costs with a varying number of firms when theta= 0.9

Fixed Costs of Exporting	Tariff									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
0 (28.40)	-0.55%	-1.09%	-1.63%	-2.16%	-2.69%	-3.22%	-3.75%	-4.27%	-4.79%	-5.30%
0.1 (22.03)	-0.49%	-0.97%	-1.46%	-1.93%	-2.41%	-2.88%	-3.35%	-3.82%	-4.28%	-4.74%
0.2 (19.75)	-0.43%	-0.86%	-1.29%	-1.71%	-2.13%	-2.54%	-2.96%	-3.37%	-3.78%	-4.18%
0.3 (18.12)	-0.37%	-0.74%	-1.11%	-1.47%	-1.83%	-2.19%	-2.54%	-2.89%	-3.24%	-3.59%
0.4 (16.84)	-0.31%	-0.62%	-0.93%	-1.23%	-1.53%	-1.83%	-2.12%	-2.42%	-2.71%	-2.99%
0.5 (15.78)	-0.25%	-0.50%	-0.75%	-1.00%	-1.24%	-1.48%	-1.72%	-1.95%	-2.18%	-2.41%
0.6 (14.86)	-0.20%	-0.39%	-0.58%	-0.77%	-0.96%	-1.15%	-1.33%	-1.51%	-1.69%	-1.87%
0.7 (14.06)	-0.15%	-0.29%	-0.43%	-0.57%	-0.70%	-0.84%	-0.97%	-1.10%	-1.23%	-1.36%
0.8 (13.35)	-0.10%	-0.19%	-0.29%	-0.38%	-0.47%	-0.56%	-0.65%	-0.73%	-0.81%	-0.89%
0.9 (12.71)	-0.06%	-0.11%	-0.16%	-0.21%	-0.26%	-0.31%	-0.35%	-0.40%	-0.44%	-0.48%
1.0 (12.12)	-0.02%	-0.03%	-0.05%	-0.06%	-0.07%	-0.08%	-0.09%	-0.10%	-0.10%	-0.11%

The table presents the percent change in welfare that results from a tariff of specified size when the number of exporters varies with the tariff. Numbers in parentheses represent the absolute value for welfare in the South in the absence of a tariff. Parameter values for the analysis are: $\alpha = 2$, $\eta = 0.2$, $\gamma = 0.05$, $c_{max} = 1$, $f_e = 1$, and $\theta = 0.90$

Table 1-7. Welfare effects under different fixed cost of exporting regimes

Regime	Tariff									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
$f_x = 0$	-0. 74%	-1.46%	-2.18%	-2.89%	-3.60%	-4.29%	-4.98%	-5.66%	-6.33%	-6.99%
$f_x = 0.5$	-0.38%	-0.75%	-1.13%	-1.49%	-1.85%	-2.21%	-2.57%	-2.92%	-3.26%	-3.61%

The table presents the percent change in welfare that results from a tariff of specified size when the number of exporters varies with the tariff. The table presents results from parameter values of: $\alpha = 2$, $\eta = 0.2$, $\gamma = 0.1$, $c_{max} = 1$, $f_e = 1$, and $\theta = 0.5$ to test robustness across differing values of γ.

Table 1-8. Welfare effects under varying levels of alpha

Fixed Exporting Cost Regime		Tariff				
	α	2%	4%	6%	8%	10%
$f_x = 0$	2.0	-1.46%	-2.89%	-4.29%	-5.66%	-6.99%
	3.0	-0.70%	-1.39%	-2.07%	-2.74%	-3.39%
	4.0	-0.46%	-0.91%	-1.35%	-1.78%	-2.21%
	5.0	-0.34%	-0.68%	-1.01%	-1.33%	-1.65%
	6.0	-0.27%	-0.54%	-0.80%	-1.07%	-1.32%
$f_x = 0.5$	2.0	-0.75%	-1.49%	-2.21%	-2.92%	-3.61%
	3.0	-0.45%	-0.90%	-1.34%	-1.77%	-2.19%
	4.0	-0.33%	-0.65%	-0.96%	-1.28%	-1.59%
	5.0	-0.25%	-0.51%	-0.76%	-1.00%	-1.25%
	6.0	-0.21%	-0.42%	-0.62%	-0.82%	-1.03%

The table presents the percent change in welfare that results from a tariff of specified size when the number of exporters varies with the tariff. The table focuses on changes in the value of α. Parameter values for the analysis are, $\eta = 0.2$, $\gamma = 0.1$, $c_{max} = 1$, $f_e = 1$, and $\theta = 0.5$

Table 1-9. Welfare effects under different fixed cost of exporting regimes (small tariffs)

Fixed Costs of Exporting	Tariff									
	0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.7%	0.8%	0.9%	1.0%
0.0 (6.54)	-0.07%	-0.14%	-0.21%	-0.28%	-0.35%	-0.42%	-0.49%	-0.56%	-0.63%	-0.70%
0.1 (6.54)	-0.05%	-0.11%	-0.16%	-0.22%	-0.27%	-0.33%	-0.38%	-0.44%	-0.49%	-0.54%
0.2 (5.36)	-0.05%	-0.10%	-0.14%	-0.19%	-0.24%	-0.28%	-0.33%	-0.38%	-0.43%	-0.47%
0.3 (5.07)	-0.04%	-0.08%	-0.13%	-0.17%	-0.21%	-0.25%	-0.29%	-0.34%	-0.38%	-0.42%
0.4 (4.92)	-0.04%	-0.08%	-0.11%	-0.15%	-0.19%	-0.22%	-0.26%	-0.30%	-0.34%	-0.37%
0.5 (4.83)	-0.03%	-0.07%	-0.10%	-0.13%	-0.17%	-0.20%	-0.23%	-0.27%	-0.30%	-0.33%
0.6 (4.77)	-0.03%	-0.06%	-0.09%	-0.12%	-0.15%	-0.18%	-0.21%	-0.24%	-0.27%	-0.30%
0.7 (4.74)	-0.03%	-0.05%	-0.08%	-0.11%	-0.13%	-0.16%	-0.19%	-0.21%	-0.24%	-0.27%
0.8 (4.72)	-0.02%	-0.05%	-0.07%	-0.10%	-0.12%	-0.14%	-0.17%	-0.19%	-0.22%	-0.24%
0.9 (4.71)	-0.02%	-0.04%	-0.06%	-0.09%	-0.11%	-0.13%	-0.15%	-0.17%	-0.19%	-0.21%
1.0 (4.71)	-0.02%	-0.04%	-0.06%	-0.08%	-0.10%	-0.11%	-0.13%	-0.15%	-0.17%	-0.19%

The table presents the percent change in welfare that results from a tariff of specified size when the number of exporters varies with the tariff. The focus of the table is on small tariffs. Numbers in parentheses represent the absolute value for welfare in the small country in the absence of a tariff. Parameter values for the analysis are: $\alpha = 2$, $\eta = 0.2$, $\gamma = 0.05$, $c_{max} = 1$, $f_e = 1$, and $\theta = 0.5$

Table 1-10. Welfare effects under different fixed cost of exporting regimes (large tariffs)

Fixed Costs of Exporting	Tariff				
	10%	20%	30%	40%	50%
0.0 (6.54)	-6.63%	-12.59%	-17.97%	-22.80%	-27.16%
0.1 (6.54)	-5.17%	-9.80%	-13.94%	-17.63%	-20.92%
0.2 (5.36)	-4.50%	-8.51%	-12.07%	-15.22%	-18.00%
0.3 (5.07)	-3.98%	-7.50%	-10.61%	-13.34%	-15.74%
0.4 (4.92)	-3.54%	-6.65%	-9.39%	-11.77%	-13.84%
0.5 (4.83)	-3.16%	-5.92%	-8.33%	-10.41%	-12.20%
0.6 (4.77)	-2.82%	-5.27%	-7.40%	-9.22%	-10.76%
0.7 (4.74)	-2.52%	-4.69%	-6.56%	-8.14%	-9.47%
0.8 (4.72)	-2.24%	-4.17%	-5.80%	-7.17%	-8.30%
0.9 (4.71)	-2.00%	-3.69%	-5.12%	-6.29%	-7.24%
1.0 (4.71)	-1.77%	-3.26%	-4.49%	-5.49%	-6.27%

The table presents the percent change in welfare that results from a tariff of specified size when the number of exporters varies with the tariff. The focus of this table is on large tariffs. Numbers in parentheses represent the absolute value for welfare in the small country in the absence of a tariff. Parameter values for the analysis are: $\alpha = 2$, $\eta = 0.2$, $\gamma = 0.05$, $c_{max} = 1$, $f_e = 1$, and $\theta = 0.5$

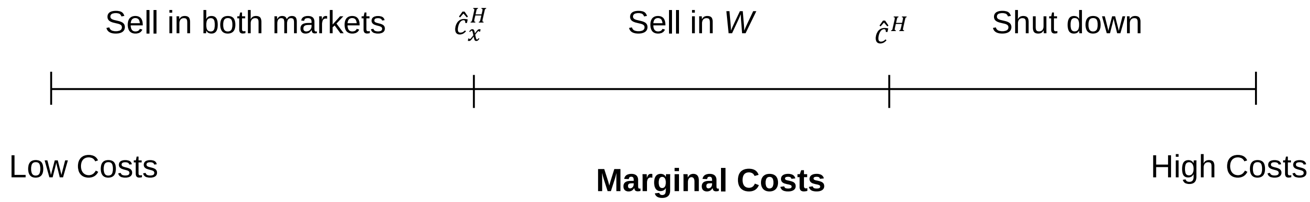

Figure 1-1. Cost cutoffs

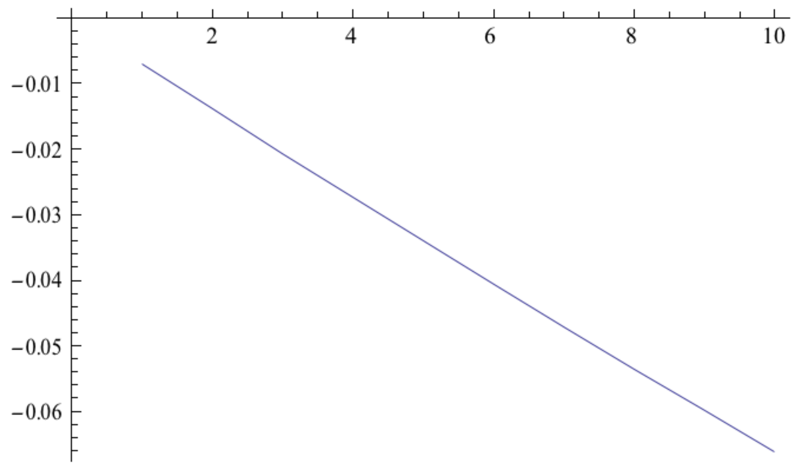

Figure 1-2. Tariffs and welfare

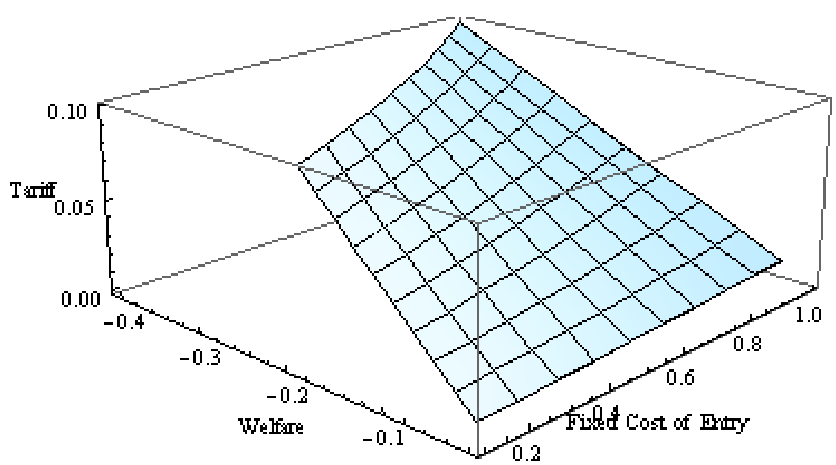

Figure 1-3. Impact of tariffs and fixed entry costs on social welfare

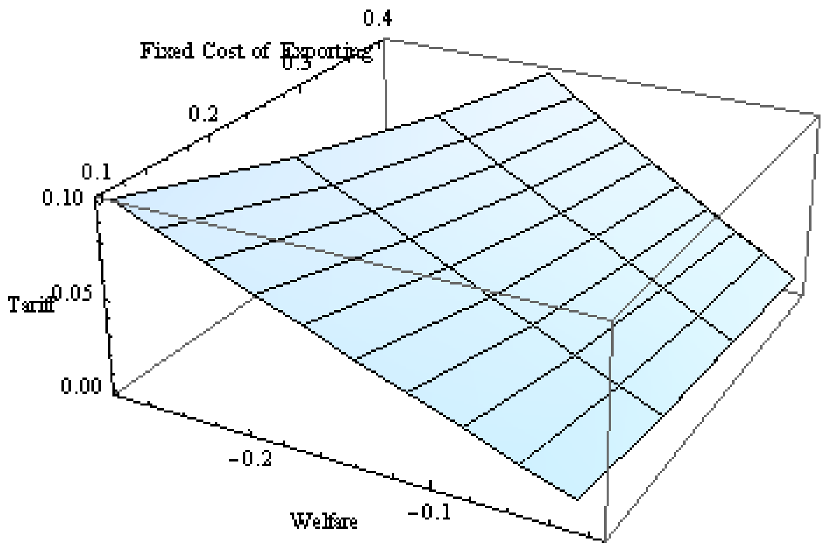

Figure 1-4. Impact of tariffs and fixed cost of exporting on social welfare

CHAPTER 2
DOES ABILITY MATTER: DETERMINANTS OF ARBITRATION OUTCOMES IN MAJOR LEAGUE BASEBALL

2.1 Introduction

There is a deep and rich literature on the causes of settlement failure in bilateral bargaining. A breakdown in negotiations can cause strikes, trials, arbitration, and general ill will. Resolving these disputes is costly for both parties, and so there is a great deal of emphasis placed on finding the root causes of these failures. There are two primary hypotheses as to why bilateral negotiations can fail in the setting under examination. The first, and probably most prominent, is the idea that there exists some difference in expectations concerning the arbitration process. That is, it is possible that one party has a greater level of sophistication in predicting the outcome.[1] The second theory is that one party may have a lower level of risk aversion than the other, leading them to take on more risk for the chance at a large payday. If one party is willing to gamble on the outcome, it is unsurprising that negotiations will break down. This theory basically states that differences in risk preferences between the two parties causes settlement failures.

I wish to test these competing hypotheses and elaborate on the economic significance of the two in the setting of Major League Baseball. Major League Baseball (MLB) provides an amazing landscape in which to look at arbitration issues due to a variety of factors. Baseball utilizes a form of final offer arbitration (FOA) in their salary negotiations. Under the arbitration rules of Major League Baseball, players and clubs both must submit publically available offers. If the two sides fail to come to an

[1] See Spier (1992) for an example

agreement, these submitted offers becoming binding once the case moves to arbitration. That is the arbitrator analyzes the offers of both parties and selects one or the other. In this setting the player either receives his own or the club's submitted offer, there is no middle ground.[2]

There are some remarkable advantages to focusing on MLB for the purposes of this paper. As mentioned, the fact that the submitted offers are binding and publically available provides remarkable insight into the negotiation process. The use of final offer arbitration is also important. Unlike many fields (other sports leagues among them) where an arbitrator often picks a final salary somewhere between the submitted offers, in MLB the arbitrators are forced to choose between the two offers. I will go into more detail later, but I assume that the bidding strategies employed by the two parties follow a structure similar to those found in Farber (1980). Farber looked at final offer arbitration and the optimal bidding strategies under these conditions. I will address this more later, but the arbitrators review the submitted offers and choose that which is closest to their preferred settlement figure. The pertinent point here is that the arbitrators must select one of the two offers; they cannot choose a final salary other than one of the two submitted offers. I rely on this characteristic in much of my analysis.

Finally, MLB is a game rich in history and reliant on individual performance statistics. Because of this, extensive historical data is recorded and kept on every person to play the game professionally. Statistics relating to salaries (both before and after arbitration), player performance, and a ball club's financial performance are all

[2] Major League Baseball arbitration cases are heard by a panel of 3 judges.

readily available. This allows for a very detailed data set to relate arbitration hearings with the resulting salary figures.

In this paper I focus on the level of "aggression" displayed by both baseball players and the clubs they negotiate with. In the context of this study, aggression has a dual meaning. If a player is said to be aggressive, it means that the player submitted an offer (request for the next year's salary) that is higher than his value that I estimate based on a list of observable characteristics. On the other hand, if a club is said to be aggressive, this implies the club with which a player is negotiating submitted an offer that is lower than his predicted market value, given that player's list of observable characteristics. These measures of aggression are determined using publically available data (which is provided to arbitrators during the hearing) to predict the salary for each player in the data set. The difference between the predicted salary and the submitted offer defines the level of aggression a player or club exhibits. This will be discussed in more detail later, but it is important to note that an optimal offer in arbitration is likely to be aggressive. These measures relate aggression relative to the "true" market value, where market value is a decision tool the arbitrator uses to choose the winner in arbitration.

Given that both parties have access to the same information concerning player performance and salaries of other comparable players, it is difficult to explain any systematic bias in the level of aggression from either party. One possible explanation is that the risk preferences of the two parties drive pairs to arbitration. If risk aversion leads to aggressive bidding, the more risk-averse party will tend to submit less aggressive bids than the other party. Another possibility exists: that the arbitrators, in their estimation of the player's value, are hampered by some error.[3] Even if both sides hold the same belief concerning the player's market value, if the error term favors one party, then that party should tend to make aggressive bids because of this error term. The details of this process will be discussed later.

It is possible to test these competing explanations empirically based on the salary results for players who go to arbitration versus those who settle prior to a hearing. If one side tends to be more risk loving than the other, the risk loving party would, on average, display higher levels of aggression. As a result of this increased aggression, it would also be expected that they would lose a majority of the arbitration cases in which they participate. In this scenario, aggression by players proceeding to arbitration will result in worse salary outcomes than their peers who settle earlier.

On the other hand, if there is an error in the arbitrator's estimation of the market value, then the results will be much different. In this case, an aggressive offer should not harm the aggressor's chances at winning in arbitration, as it reflects some knowledge about the arbitration process. As a result the more aggressive party should not suffer from a lower win rate in arbitration. In addition, if there is a known pattern in the error term, the average salary of those aggressive parties that proceed to arbitration should be higher than their peers who settle early (again assuming players are the player in question, while the opposite logic holds true for clubs).

The model used will be discussed later in this paper, however at this point it is possible to make some general statements about the implications of any potential

[3] When arbitrators analyze a case they are given a full list of current players and their salaries. The arbitrators are excluded from using salary information or the financial position of a specific club when making a decision. The goal of the arbitrators is to compare a player's performance to the overall league average and respective salaries.

results. If differences in the risk preferences of the two parties is the cause of aggression in the submitted offers, it is expected that the more aggressive party would tend to lose a majority of the cases. In addition, if the preference for risk is high enough, the side with a higher risk preference will fare worse in arbitration than they otherwise would by settling early. That is to say, if players tend to be more risk loving than teams, we would expect a higher level of aggression on the side of players. As a result, the players will lose a disproportionate number of cases as a tradeoff for chasing a larger payday. If the probability of victory drops below a certain point, the expected salary from arbitration falls below the level that would be expected with a settlement.

If, instead, an error in the arbitrator's estimates drives aggression, then the observed aggression instead indicates that the party that is acting aggressively has some level of sophistication in their approach to the arbitration process. In this scenario, increasing the level of aggression should have no discernable impact on the probability of a victory in arbitration. More importantly for this paper, the results from arbitration should actually be, on average, better than those who settle early. This implies that if the regressions show that aggressive parties do worse in arbitration, it is most likely a case of risk loving behavior. On the other hand if aggression results in higher expected salaries, it seems likely that some error in the arbitrator's decision rule plays a role.

Finally I find that the position of a player plays a role in this process. The results are very straightforward for players who primarily play in the field and bat (known as position players). On the other hand, the results are much more ambiguous for players who pitch. It seems likely that due to the unique role of the pitcher, determining their value (and identifying meaningful statistics to utilize) is more difficult. I hope to look into this issue further in future research. One clearly confounding factor is the various roles that pitchers may play. Some pitchers act as starters, and pitch several innings at the beginning of the game. Their appearances in a season are limited as their workload per outing is high. There are also “closers” who often pitch one inning per game at the end of the contest. These pitchers have a lower workload per outing but appear much more frequently during the course of a season. Finally there are “middle relief” pitchers who occupy a middle ground. They pitch towards the end of the game and have limited innings, though more than closers. The number of their appearances tend to end up somewhere between the two aforementioned categories. These roles all vary in terms of their contribution to team success and create difficulty in their analysis.

Farmer, Pecorino, and Stango (2004) first looked specifically at arbitration in Major League Baseball. They used a similar data set to examine settlement failure in MLB. Their work differs in two key areas. First, their data set is limited to a three-year window, allowing only small sample sizes to work with. In this paper I look at a set of data that stretches 17 years (1987-2004) which allows for much larger sample sizes. In addition, there are some key differences in methodology in determining aggression and the possible conclusions from the data that will be discussed later. This paper also shares a common theme with Waldfogel (1998), who looks at civil litigation as opposed to arbitration. The key difference is that in civil litigation, submitted offers are not binding. In addition, Conlin (1999) shows that holdouts in the National Football league primarily occur due to asymmetric information. He shows that holding out is a method for players to convey their private information concerning their ability. Hayes (1984) examines similar issues in labor union strikes. The key difference here is that there is no possibility of a “strike” as the rules of arbitration force both parties to follow the decision of the arbitrator. The club must sign the player, and the player must compete for the team or forgo the entire following season. As alluded to earlier, the arbitration process in baseball is unique. Players become eligible for arbitration following their third year of play and are eligible every year thereafter until they obtain 6 years in the major leagues. Once eligible they are free to negotiate their salary directly with their clubs. If they fail to come to an agreement by some predetermined deadline, the players then file for arbitration. Filing for arbitration is a binding agreement to abide by the arbitrators’ decision. Thus the threat of strike, so prominent in other studies, is absent here.

2.2 The Model of Final Offer Arbitration

2.2.1 Theoretical Framework

I utilize a variation of a basic model for optimal bidding strategies in final offer arbitration, which was first proposed by Farber. The model presented in this work assumes three parties: the club, the player, and the arbitration panel.

For the purposes of this model, I assume that y generally refers to the salary of the player that is under negotiation. The arbitrator estimates the true market value of the player, y_M, (this market value is not a function of the final offers of either the player or the club but rather the player characteristics) but with some level of error, which I denote with ε. This leaves the arbitrators’ estimate of the value of the player as $y_A = y_M + \varepsilon$.

Given this scenario, both clubs and players submit their bids. Let y_P represents the offer submitted by the player and y_C represents the offer submitted by the club. Given this setup the offer of the club will be chosen in arbitration if:

$$|y_A - y_C| < |y_P - y_A|$$

and the offer of the player will be chosen otherwise. It makes sense in this setting to assume that $y_C < y_P$ so it is possible to drop the absolute value signs while simultaneously substituting in the equation for the arbitrator's value, leaving:

$$y_M + \varepsilon - y_C < y_P - y_M - \varepsilon$$

Rearranging and noting that ε is a random variable yields:

$$\Pr(Club\ Win) = Pr\left(\varepsilon < \frac{y_c + y_p}{2} - y_M\right)$$

Intuitively this implies that the club will win in arbitration if the difference between the average of the offers and the true value of the player is greater than the arbitrator's error term. As noted in Blair (2012), the arbitrators make their decision based on the midpoint of the two offers. Here I expand on that by adding a potential error term to this estimation process. The above equation can be rewritten as:

$$\Pr(Club\ Win) = F\left(\frac{y_c + y_p}{2} - y_M\right)$$

Thus it is possible to write the expected utilities for both the club and the player as:

$$\mathrm{E}(\mathrm{U}_P) = \left[1 - F\left(\frac{y_c + y_p}{2} - y_M\right)\right] U_p(y_p) + F\left(\frac{y_c + y_p}{2} - y_M\right) U_p(y_C)$$

and

$$\mathrm{E}(\mathrm{U}_C) = \left[1 - F\left(\frac{y_c + y_p}{2} - y_M\right)\right] U_C(1 - y_p) + F\left(\frac{y_c + y_p}{2} - y_M\right) U_C(1 - y_C)$$

Now both parties maximize their utilities presented above through their bids. Differentiating both and setting to zero yields:

$$\frac{1}{2} f\left(\frac{y_c+y_p}{2} - y_M\right)\left[U_p(y_C) - U_p(y_p)\right] + F\left(\frac{y_c+y_p}{2} - y_M\right) U'_p(y_P)$$

and

$$\frac{1}{2} f\left(\frac{y_c+y_p}{2} - y_M\right)\left[U_C(1-y_C) - U_C(1-y_p)\right] - F\left(\frac{y_c+y_p}{2} - y_M\right) U'_C(1-y_C)$$

Solving both equations simultaneously leaves:

$$\frac{F\left(\frac{y_c+y_p}{2} - y_M\right)}{\left[1 - F\left(\frac{y_c+y_p}{2} - y_M\right)\right]} = \frac{\left[U_C(1-y_C) - U_C(1-y_p)\right]}{U_p(y_C) - U_p(y_p)} \times \frac{U'_p(y_P)}{U'_C(1-y_C)}$$

Where the left hand side is the relative odds of the club winning in arbitration.

It is important for this paper to note that absolute risk aversion is defined in the same manner as Pratt (1964):

$$\delta(y) = -\frac{U''(y)}{U'(y)}$$

As a result, the club is more risk-averse than the player if $\delta_C(y_i) > \delta_P(y_j)$ for all y_i and y_j.

2.2.2 Empirical Implications

There are several papers that look at settlement failures in the context of civil litigation.[4] Several studies look at optimism driven settlement failures. In these papers, the cause of excessive optimism stems from a random draw that both parties receive concerning their information regarding the negotiation. I build on this assumption by adding an error term to the arbitrator's true valuation of the player's value. This implies that settlement failure may simply occur due to contrary beliefs concerning the arbitrator's error in assessing the player's value. There are two primary reasons settlement failure may occur in the MLB setting. Negotiations might fail because the

[4] See Shavell (1982) and Priest and Klein (1984) for examples.

parties have different knowledge or beliefs concerning the error term in the arbitrator's decision. If one side knows they are favored in the impending arbitration process due to some knowledge concerning the error term (for example, regular tendencies in one direction) this may lead the favored party to intentionally drive the pair to arbitration. On the other hand, the parties might differ in their level of risk aversion. In this scenario one party may prefer arbitration because the payouts from a win (even if the likelihood of winning is small) outweigh the losses from a potential unfavorable ruling.

These two scenarios result in very different predictions about the expected patterns concerning arbitration. If there is some pattern in the arbitrator's rulings, then the favored party will bid more aggressively in negotiations. If this aggressive behavior is truly indicative of some characteristic in the arbitrators' error, this should, on average, result in a favorable outcome for the aggressive party. This implies that a majority of the cases heard should result in a favorable outcome for the aggressive party. If this is the case, it is expected, ex ante, that the aggressive party that *does* proceed to arbitration should do better than their peers who do not. For example, if players are consistently favored in arbitration then, ceteris paribus, players who proceed to arbitration should earn higher salaries than players who do not. That is to say, when aggressive players proceed to arbitration it indicates that they are being systematically favored (due to the error term) in arbitration, and thus achieve higher salaries than their peers. This is a simple extension of the idea that if aggressiveness indicates a predisposition on the part of the arbitrator, then the aggressive party should win a high percentage of the cases in arbitration, resulting in overall higher salaries.

On the other hand, aggressiveness might be an indication about each party's level of risk aversion. If this is the case, then aggressive behavior by one party might simply indicate a greater propensity for risk taking behavior than the other party. In this case, the level of aggression is not necessarily correlated with the odds of winning in arbitration. This scenario yields empirical predictions that are opposite those presented earlier. Aggression should be associated with lower probabilities of victory and thus worse payoffs. These are the two primary theories tested in this work.

2.2.3 Understanding Arbitration in Major League Baseball

Understanding the arbitration process in Major League Baseball (MLB) is instrumental to analyzing player and club behavior throughout the ordeal. Due to the fact that arbitration in MLB negotiations involves final offers by both parties, it is a high stakes negotiation. Players become eligible to file for arbitration upon completion of their third year in the major leagues, and maintain the right to file until the offseason after their sixth year in the league.[5] The arbitration process is broken into stages, which allows for convenient analysis of the results. Cases may settle in any one of four separate stages. The stages proceed as follows:

Stage 1: The team and player may settle on a salary before the deadline for filing for arbitration.

Stage 2: The team and player may settle on a salary after filing paper work but prior to submission of legally binding offers to the arbitration panel.

[5] Players are granted eligibility upon completion of their third year of major league employment. In rare cases (when a player has completed a full 2 years with a team and has played a substantial portion, but not a complete season for a third year), players are granted eligibility on a case-to-case basis.

Stage 3: The team and player may settle on a salary after the submission of salary offers but prior to hearing a decision from the arbitrator.

Stage 4: The team and player may be assigned a salary by the arbitrator. The arbitrator must choose between the player's offer and that of the club.

Players from stage 3 and 4 provide the data for this analysis. Overall, this process allows an in-depth examination of the causes of bargaining, as it affords the opportunity to look at the reasons why the parties do not settle prior to the high stake arbitration stage.

2.3 The Data

For this paper, I focus on the arbitration outcomes for players eligible in the years 1987 – 2004. One the primary additions of this paper to previous work, is the increased depth of data in terms of the years examined. By covering an expanded range of years, I am able to examine the settlement decisions of the 1,641 players who were eligible for arbitration in this time period.[6] In over 75% of these cases, the player and team failed to come to an agreement in stages 1 or 2. This means that for a majority of these players, data concerning the submitted offers is publically available. Out of the entire sample, 236 players (roughly 14%) of players proceeded to stage 4 of the arbitration process. Out of those players who chose to pursue final offer arbitration, only 41% won their case.

Before moving to data analysis, it is useful to look at a few descriptive statistics. Table 2-3 presents some of the basic characteristics of the data set. I chose to separate players based on the position they play. In baseball there is a fairly clear

[6] We exclude players without enough playing time the year before to have compiled any stats and those whose salary data is missing. This occurs if a player did not make the 40-man roster the previous year.

distinction between players in the field and pitchers. The attitudes towards the two different groups, and the compensation they receive can differ greatly. It seems plausible that arbitration results may vary for these two subsets as well.

It is also worthwhile to look at the difference between the final negotiated contract and the average of the two submitted offers. As Table 2-3 shows, clubs generally come out ahead in these negotiations. Across the entire sample, the average inflation adjusted salary for the following year is $30,819.63 less than the average of the submitted offers. It is worth noting that even with these basic statistics it is evident that, at least anecdotally, proceeding to arbitration yields a net negative result for the players. For those who do choose to move to final offer arbitration, their final salary is, on average, $39,330.05 less than the average of the two submitted offers, while those who settle before arbitration suffer a much smaller hit: only $28,869.85 less than the average of the submitted offers.[7] While this, in and of its self, does not prove that the team is at an advantage in arbitration hearings, it does suggest that reasons behind a club/player moving to arbitration are usually in the clubs' favor. It seems important to make a statement about player salaries in MLB. The growth in player salaries over the last 40 years has far outpaced inflation in the rest of economy. While this is of some concern, I control for this by deflating all salary data by CPI, but also include yearly dummy variables. This should control for any abnormal single year growth in real player salaries.

[7] In addition, this number is actually biased upwards. Some players who settle prior to arbitration sign multi-year contracts. It is common practice for the first year of these contracts to be well below the original offer by the club but grow quickly in the years after. This means that almost all players who signed multi-year contracts signed for salaries well below the midpoint of the two offers, but with knowledge that their salaries will be much higher a few years later.

One of the main additions of this paper is the attempt to capture the more sophisticated "Sabermetric" techniques that have become popular in Major League Baseball over the last two decades.[8] There are a slew of Sabermetric statistics that are used by analysts and teams alike in order to evaluate players. In this paper, I decide to focus on the measure referred to as Wins Above Replacement (WAR).[9] WAR attempts to measure a player's contribution to the number of total team wins, relative to a generic replacement player. There are several advantages to using WAR over classic performance indicators such hits and home runs. Firstly, WAR is a relatively popular statistic in baseball circles. It is fairly straightforward to gather this data on players dating all the way back to the 1800s from sources like Baseball-Reference. In addition, it is non-specific to a position or manner of contribution. Instead, it represents a holistic analysis of the player's overall contribution to a team's bottom line. By stratifying the sample across those players who end up in arbitration and those who don't, it is readily apparent that players who end up in arbitration are objectively better players.

Upon further examining the stratified descriptive statistics another fact becomes apparent. Although teams tend to win if negotiations proceed to arbitration, average salaries for those who wind up at this stage are still higher than those who settle early. This simple result replaces findings from earlier works. By expanding the sample size, it

[8] Sabermetric refers to any non-traditional measure of player performance. It is a general term taken to mean any composite measure of statistics used in an attempt to objectively measure and compare player performance. These measures eschew traditional measures of performance (such as hits and home runs) in favor of situational statistics that better measure a player's impact on the outcome of the game. For example, a player may hit 25 home runs (usually considered a very decent year) but if all of their home runs came in situations where the game was already decided, they did not have a large impact on the total number of wins their team compiled. In comparison another player may have hit only 10 home runs, but if every home run hit was in a game that was still within 1 run, their impact on the team's win total is much greater.

[9] For more information on the Wins Above Replacement measure please see baseballprojection.com and Appendix B

becomes clear that higher performance does in fact lead to higher pay. There are two possible casual interpretations of this data. First, it may be the case that going to arbitration is not nearly as detrimental to the player's future earnings as previous studies suggest. An alternative interpretation is that the gap in quality between players who proceed to arbitration and those who settle is so large that the higher skill level offsets potential loses experienced in the arbitration process. This paper will attempt to examine these competing hypotheses later.

One of the most controversial decisions in this analysis is how to measure what previous papers have referred to as the "aggressiveness" of the submitted salaries by clubs and players. This section will present the methods available and discuss the econometric repercussions across the techniques. Regardless of the exact method of determining how high or low a particular offer is from a club or player, some of the same principles apply across the board.

I start by compiling publicly available data as it relates to both the individual player for the year in which they file for arbitration, as well as some basic information about the club they play for. Using this data, I then try to estimate the market value for that player in the following year.

At this point it is worthwhile to discuss the various methods that could potentially be used to gauge how reasonable a submitted salary is on the part of either the club or the player. Farmer, Pecorino, and Stango propose regressing the submitted offer against a list of observables. Their proposed econometric relationship is:

$$\ln Offer_{it+1}^{j} = \mathrm{X}_{it}\beta+\varepsilon_{it} \qquad (2\text{-}1)$$

where the left-hand side of the equation captures the natural logarithm of the offer submitted by either the player or the club (indexed by the superscript j). They estimate this equation separately for offers made by the club and the player. The vector *X* incorporates all of the general statistics concerning the player's ability as well as club specific measures. The subscript *i* denotes the particular player/club pair in question, and the subscript *t* denotes the year of the negotiation. Farmer et al. capture yearly differences using dummies (a process which I mirror in this paper as well). The vector *X* includes variables such as the previous salary of the player, basic performance statistics, and an overall player performance rating. Farmer et al. further stratify their data based on prior experience in arbitration.

The choice to use the logarithmic transformation in relation to salary is commonplace and provides two distinct advantages. The first reason for doing this is that it eliminates much of the skewedness that exists in both the actual salary data as well as the submitted offers. In addition, it allows the analysis to focus on percentage deviations as opposed to raw salary differences. This will be useful in examining relative aggressiveness of offers.

It is then possible to use Equation 2-1 to predict the expected offers on the part of both the club and the player. Farmer et al. then find what they refer to as the residuals from the equation. For each observation they find the difference between the predicted offer and the actual offer submitted. This difference is used as their measure of aggressiveness. A negative "residual" denotes a low-ball offer while a positive residual denotes an aggressive offer. It is then possible to use these residuals to look at the effect of aggressive/soft offers on the actual salary of the player in the following year.

This method raises some issues that must be addressed.[10] This method assumes that on average, players and clubs alike will submit a “reasonable” offer. That is, if the submitted offer is used as the independent variable, the working premise is that each party will submit offers that are fair based on a player’s and club’s observable data. However, if there is any systematic bias to the process of submitting offers (say players tend to overstate their value), then even if a player or club submits an unreasonable offer relative to the player’s true market value, it may appear that the offer is neither soft nor aggressive. Because of this issue, using the offers as the dependent variable is not an appropriate method for determining the aggressiveness of submitted offers.

In this paper I propose an alternative, which, not only attempts to capture the aggressiveness of a particular player/club, but also examine if there exists systematic overstating or understating of value in the offers. The basic framework of the model remains unchanged. The key difference is that instead of using the offers of players and clubs as the dependent variable, I use the eventual salary of the player in the following year. This yields the following econometric relationship:

$$\ln Salary_{i,t+1}^{j} = \mathrm{X}_{it}\beta + \varepsilon_{it} \tag{2-2}$$

[10] Farmer et al. do address many of the standard econometric concerns from this method in their paper. However one key point goes unmentioned. By utilizing this method, the OLS regression serves to find the line of best fit thus basically minimizing these levels of aggression. The same is also true for the average level for clubs. It seems slightly arbitrary to measure the level of aggression in this manner and ignores systematic bias in offers.

where the differentiating element is in the dependent variable. The goal in this is to provide an estimate for the true values of all players based upon actual salaries. This implies that the dependent variable ($lnSalary_{i,t+1}^{j}$) acts as a proxy for a player's true value. Thus, when I run this regression, find the predicted coefficients, and apply those to predict a salary, what I am really doing is estimating the players' true market value (y_M). That means that when I take the estimated coefficients and use them to predict next year's salary, I am actually estimating a value for $\hat{y}_M$. So the predicted salary takes the place of the true value of the player, which is unobservable. Thus, one would expect the arbitrators to arrive at a similar value (with some error), which will be used to inform their decision in arbitration. Based on the theoretical model proposed earlier, it is expected that there will be some aggression on the part of both parties. However, here the issue present in Farmer et al. is avoided, as this analysis is not reliant on bids with zero average aggression.

This also allows a simple way to analyze the level of aggression displayed by both parties. Since, the offers submitted by both sides are publically available, it is possible to arrive at an estimate of the aggression by finding the difference between the estimated true value from the regression ($\hat{y}_t$) and the offer submitted by either side. The measure utilized in this work is the percentage difference between the submitted offer and the estimated true value of the player. Also of note, I control for the fact that aggression looks different for each party. For a player, aggression displays itself as an offer that is above the player's true value. However, aggression on the part of a team would actually be a submitted offer below the estimated true value of the player.

The decision to use the following year's salary has some advantages from an econometric standpoint. In using this measure, I am able to get a stronger estimate of how aggressive an offer is relative to the player's true market value. In Farmer et al., by definition their average residual measures must be equal to zero. Using Equation 2-2, it is possible to capture general trends across players or clubs, as an entire group. In addition, it also possesses the relatively straightforward advantage of expanding the sample size used for the predicted salaries. By regressing next year's salary on an extensive list of observables, it is possible to get a much more accurate picture of the true market value for a given player.[11]

While this method does offer some advantages, it is true that some problems remain. If there are any missing attributes, that both the club and player observe, but are not captured in the data, it is possible that this equation may falsely estimate aggression where none exists, and vice versa. This is the single largest draw back in utilizing Equation 2-2 over Equation 2-1. Despite this concern, by the time offers are submitted both sides are aware of the stakes: these offers represent the final offer should negotiations fail. As discussed in theoretical model, these bids should represent the optimal bids, which are different from the true value of the player. This is the strongest argument for using Equation 2-2.

The results from the salary regressions in Equation 2-2 are presented in Tables 2-1 and 2-2. These are separated by position, with the results for pitchers being presented in Table 2-1 and the results for position players being presented in Table 2-2.

[11] This allows regressions on all players that are eligible for arbitration, and not just those who submitted offers. This expands the sample under analysis by roughly 25% to over 1400 observations. This also allows me to run separate regressions on Equation 2-2 for position players and pitchers while still obtaining a high level of statistical significance.

I have also provided histograms of some key features of player aggression. Figures 2-1 through 2-10 all display density plots of the level of aggression, whether it be on the part of the player or the club. Figures 2-1 through 2-5 display player aggression. Figure 2-1 represents a good baseline for player aggression, as it is a simple plot of all players in my sample who submitted offers. Figures 2-2 through 2-5 display other plots of player aggression based on key characteristics. It is interesting to note that the distribution of aggression is fairly consistent across demographics, though it looks like those who proceed to arbitration are more aggressive. The same is true of those who win in arbitration, but this subsample is biased as they represent only players for which negotiations had already failed. Figures 2-6 through 2-10 display the exact same data, but for club aggression. These figures are more interesting, as it seem clear that for those players who win in arbitration, clubs are more aggressive than the sample as a whole.

2.4 Results

2.4.1 Salary Estimation

As mentioned earlier, I run a baseline regression in order to estimate the predicted salaries for all players in the data set. Here I take final salary in the following year for all players that are eligible for but did not proceed to arbitration, and regress their final salary against a list of observable characteristics. For position players this includes common statistics such as hits, home runs and runs scored. For pitchers this includes statistics such as earned runs allowed and strike outs. The results of these regressions are then applied to all players to predict their expected salary in the following year. This is done in an effort to capture the true market value of all players in my sample and later to analyze the results of aggression in the arbitration process.

Turning to Tables 2-1 and 2-2, it is clear that most statistics have the expected impact on player salaries. For pitchers, having a higher ERA results in a lower expected salary while more strike outs, outs pitched, wins, and saves all have the expected effect of increasing players' expected salary. Wins Above Replacement (WAR) has a very strong positive impact on salaries, as does the player's previous salary. Perhaps the only surprising result in this regression is that the pitchers' loss total is not statistically significant. This is not that startling as the number of wins a pitcher has is closely related to the number of losses.

Most performance statistics for position players have the expected sign. Oddly, having a better batting average results in a significantly reduced expected salary for players. Again it may simply be that batting average is so closely related to many of the other statistics under examination that this complicates matters. In addition batting averages tend to be a very tightly clustered statistic. For position players, the mean batting average in the sample was 0.266 with a standard deviation of only 0.039. It is also interesting to note that when hits are excluded from the regression the sign of the coefficient flips and is statistically significant. It seems that hits captures a great deal of the positive impact seen from players reaching base. It is for this reason I drop the batting average measure from the other regressions.

2.4.2 Data on Aggression

Table 2-4 presents the basic statistics from the first stage analysis of Equation 2-2. As mentioned before, results are separated by two key demographics: players whose primary role is batting/fielding and those whose primary role is pitching.[12] These

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[12] In MLB this is sometimes an ambiguous distinction. MLB is split into 2 leagues, one in which pitchers are also required to take turns batting (The American League) and another where they do not (The

statistics expand on the anecdotal evidence presented in Table 2-3 previously. The first two rows display the average club and player offers as well as their standard deviations (in parentheses below). Clearly, players request higher salaries than the clubs. If this were not the case the validity of the data set would be highly questionable. The next two rows attempt to capture the level of disagreement between the club and player in each negotiation. Row 3 displays the level of disagreement measured in log-difference. Row 4 captures the same idea in a slightly different manner. Row 4 simply finds the percentage difference between the final salary and the gap between the two offers. This puts the level of disagreement into perspective relative to the stakes. The disagreement may be large in absolute value terms but this means little without understanding the value of the final salary for comparison. Regardless of the method employed, it is clear that the player/club pairs that proceed to arbitration have a higher level of disagreement than those that settle prior to the final stage. The fourth row provides additional information. By comparing the final salary to the average offers, I am able to examine how players end up performing relative to the average bid. Contrary to some previous findings, players who proceed to arbitration actually receive a higher relative salary than those who settle. Again, I hypothesize that in my sample the quality of players that proceed to arbitration is high enough to more than offset losses incurred during the arbitration process. One might be tempted to claim then that players are well served allowing the arbitrator to settle disputes, but without controlling for the differing quality of players this is unverifiable at this stage.

National League). Further complications are added in that teams participate in “inter-league play,” where the rules from the league in which the home team plays are followed. This results in some at bats for pitchers in the American League. I attempt to avoid confusion and unnecessary complication by considering only a player’s primary role. If a player has any pitching statistics (as it is vanishingly rare that a fielder will also pitch) they are classified as a pitcher for that particular year.

The final two rows show the measures of aggressiveness for both players and clubs. As mentioned earlier, these are calculated using the difference between the actual offer submitted by either the player or the club and the predicted market value estimated using Equation 2-2. Note that these measures are calculated in such a way that regardless of the agent (player or club) a positive value denotes aggression while a negative value denotes a soft offer. Again, these two rows highlight the primary difference between this study and previous works. Here it is evident that there is some regular bias in the aggressiveness of offers. It is clear that both sides tend to submit offers that are on the aggressive side, however an interesting pattern emerges. First, for the player/club pairs that do not proceed to arbitration, the club is actually the more aggressive of the two parties. However, for those who do continue to arbitration, roles reverse and the players become the more aggressive of the two. Anecdotally, this would indicate that an aggressive club offer conveys some private information in the negotiations. Secondly, for teams the level of aggression remains basically unchanged regardless of whether the dispute is settled prior to or during arbitration. However, that is not the case for players. The average level of aggression that occurs on the players' end jumps from 15.53% to 20.95%. Also worth noting is that the standard deviations are invariably higher for those that proceed to arbitration. It seems that some level of uncertainty may contribute to failures in settlement. Whether this supports the idea that differences in risk preferences or error in the arbitrator' estimation is the primary cause is uncertain, but it is clear that players appear to be the driving force behind the failures to settle early.

This data tends to imply that players are the primary culprits behind failed negotiations.[13] However, the primary concern of this paper is to determine the causes behind failed negotiations, not just which party is at fault. The goal is to determine what is the primary culprit behind settlement failures. At this point, the data fails to provide any real clues as to the driving force behind failed negotiations.

2.4.3 The Causes of Bargaining Failure

In this section I analyze the relationship between the offers submitted by both parties and the odds that the player/club pair will end up in arbitration. This is the first time it is impossible to test the two plausible hypotheses regarding causes for bargaining failure. If aggressiveness simply reflects the possession of information that is unmeasured via the available statistics then there should be no correlation between aggressiveness and the probability of arbitration. On the other hand, if either of the two hypotheses is the root cause, then correlation should exist between aggressive behavior and arbitration hearings.

The results of this analysis are intriguing. I ran a variety of specifications for the probit regression, testing the likelihood of continuing to arbitration against possible determining factors. While several include specific player statistics (such as home runs, at bats etc.) it seems that the catchall measure of WAR captures the vast majority of influence that ability (as measured by performance statistics) has upon whether a player/club pair continues to arbitration. Table 2-5 summarizes the results of these regressions.

[13] While relatively trivial in regards to the conclusions of this paper, it is interesting to note that this is the first study to find that in all cases it appears that players are driving the pairs to arbitration through over aggressiveness. The proposed reason for this is that this is the first paper to estimate aggression in this manner, attempting to compare bids to true market value. Using the method proposed by Farmer et al. it is impossible to avoid the parties switching places as the aggressive party when segmenting the sample.

It is worth noting that as Pagan (1984) shows, when using generated regressors, the standard errors are often not consistent. Fortunately, for the purposes of this analysis, the issues regarding standard errors are minimal. However, I do bootstrap the standard errors to increase the accuracy of the results. This is the case for all regressions that involve any measure of aggression, owing to the fact that all of the measures of aggression utilized are derived from the predicted salaries of players. Since these predicted measures stem from estimates of a previous regression, it follows logically to control for any problems in the standard errors.

The results of the probit are presented by position. The first column displays the results from analysis of all eligible players; the second limits the results to pitchers, and the third column to position players. After testing several specifications, it is obvious that player ability is not a very strong determinant in driving player/club pairs to arbitration. WAR does have a statistically significant impact on the odds of arbitration, but it far from economically so.

When looking at the entire sample, the measures that stand out are the level of aggression in submitted offers (on both the club and player side), the players' previous salary, whether the player was previously eligible for arbitration, and the overall payroll of the team. In the specification that included all player/club pairs, these were all statistically significant at 5%. The results are perhaps unsurprising for a majority of these measures. Aggression by either party increases the odds of proceeding to arbitration to a significant extent. A one standard deviation increase in aggression on the part of the player increases the odds of arbitration by 36.2%, while the same on the part of the club increases the odds of arbitration by 29.5%.[14] This provides a fairly convincing argument that high offers by players and low offers by clubs are a driving force behind arbitration. In addition, if a player had been eligible for arbitration in the past, this significantly decreases the odds of proceeding to arbitration. Finally, the higher the player salary, the more likely the player is to move to arbitration; while the higher the payroll of a team the lower the likelihood that the player/club pair ends up in arbitration.[15]

I run the same marginal effects test broken down by position. The results of these regressions further reinforce the stated findings. For both position players and pitchers, the results are the same. Higher levels of aggression on the part of the player correspond directly to higher odds of arbitration. For position players a one standard deviation increase in the level of increases the odds of arbitration by 27.2%. For pitchers the results are similar. A one standard deviation increase in their level of aggression increases the odds of arbitration by 52.63%. Both of these findings reinforce those stated earlier and both are statistically significant at a 5% level. When players are aggressive their expected salaries decrease. The real take away is that aggression on the part of players corresponds to a decreasing likelihood of victory in arbitration. As it stands, this seems to support the conclusion that players are more risk loving, valuing the potential high payoffs over the increased odds of losing in arbitration.

[14] I employ the fairly standard method for probit models when computing marginal effects; the marginal effect here is the partial derivative computed at the mean.

[15] Previous studies also support this hypothesis. In general, it seems that teams that have more resources at their disposal are willing to settle with players at higher salaries in an effort to avoid arbitration. If possible this is considered a good move on the team's part as arbitration proceedings can cause ill will between the player and management.

Likewise, the club results also support the idea that clubs have a better read on the arbitrator's error term. When a club is aggressive (recall this implies lower than market value bids), the result is a lower than expected salary for players as well. For position players, a one standard deviation increase in club aggression results in a 3.47% higher probability of arbitration and for pitchers the result is a 38.3% increase. Both scenarios support the idea that aggression on the part of the clubs signifies some knowledge of the arbitrator's error term.

All other issues aside, it does seem that for position players the theoretical predictions from earlier apply, in that aggression by players is correlated with lower salaries (all else equal) and a lower win rate. Simultaneously, aggression on the part of the club tends to correlate with higher win probabilities and favorable outcomes for the aggressive clubs, indicating that the club might be aware of some arbitrator disposition in their favor. Looking at the results from this section, it is unclear which might be the driving force behind failed negotiations. Being that the relative magnitude in the probit is similar for club and player aggression, further tests are necessary to pinpoint the causes of these bargaining failures. In Section 2.4.4 I examine the impact of aggressiveness on the ex post salaries in an attempt to discriminate between the two possibilities suggested above.

2.4.4 Risk Aversion or Arbitrator Error: The Results of Arbitration

It is worthwhile to begin this section by briefly discussing the two hypotheses under consideration developed in the theoretical section earlier. The first hypothesis suggested by Farmer et al., is that simple over-optimism on the part of one party may cause a failure in salary negotiations. This paper seeks to expand on this idea by applying some economic rationale to explain why parties may behave in such a manner.

The “over-optimism” proposed by Farmer et al. simply referred to the idea that one party might overestimate their likelihood of winning. In an economic context it makes more sense that the source of overly optimistic bids stems not from misinformation (since all performance data is public and easily accessible) but rather simple differences in risk aversion. If differing levels of risk aversions are the cause behind failed negations, there are certain empirical outcomes that one may expect. In this setting, more aggressive offers from one party imply that the party is more risk loving. In this case an aggressive bid implies that the party is more willing to take on risk and the potential of a higher payoff simply outweighs any potential losses they may face. From an empirical standpoint, this implies that if differences in risk preferences drive aggressive behavior, it is expected that aggressive individuals who proceed to arbitration face worse outcomes than their peers who avoid arbitration. That means the aggressive party should face higher loss rates as well as lower ex post salaries (when the party referenced is the player).

If, on the other hand, some knowledge about the arbitrators’ error term drives aggressive behavior, a different set of empirical outcomes will be observed. In this case, aggressive behavior implies that the party knows their odds of winning in arbitration are artificially high. This implies that aggressive parties that proceed to arbitration should win a majority of their cases and experience more favorable outcomes (in terms of salary) than their peers who avoid arbitration.

The specification used for the salary equation is similar to that of the method used earlier to estimate aggressiveness of offers. The ex post salary is taken as a function of the observable player and club characteristics, as well as a set of variables that attempt to capture the level of aggressiveness of the two offers.

$$\ln Salary_{i,t+1}^{j} = X_{it}\beta + \varepsilon_{it} \tag{2-3}$$

where the primary difference between Equations 2-2 and 2-3 lie in the fact that 2-3 includes measures of aggressiveness. In order to fully capture the impact of aggressive offers on the resulting salary I include three separate variables: the base measure of aggressiveness estimated from Equation 2-2 for both clubs and players, an indicator variable to capture whether the offer submitted by the party is aggressive (positive) or soft (negative), and an interaction term between the variables of the first two. The logic behind including these measures is that the impact of aggression may vary based on whether the offer is soft or aggressive. For the sake of rigor, I include three specifications in most salary regressions:

1. Only overall measure of player and club aggression.
2. Overall measure of player and club aggression and dummies for aggressive behavior.
3. Overall measure of player and club aggression, dummies for aggressive behavior, and an interaction term between the two.

As before, I run separate regressions based on the position of the player (pitcher or fielder). Also, I continue to focus the analysis primarily on position players for the reasons discussed earlier. I will return to this issue later. To control for the fact that selection into arbitration is not done by random experiment, I employ a two-step approach. The results from the regression on all position players are presented in Table 2-6. This table presents results from the three regression specifications. The results are robust across all three specifications with no meaningful statistical difference in the results on the primary variables of interest. As can be seen in the tables, there is very little practical difference as a result of these specifications. I also suppress most of the variables on the right hand side of the equation in order to better focus on those of interest. Note that the variables of interest can be broken into two subcategories: those that capture aggression on the part of the player and those that capture aggression on the part of the club.

The coefficient on player aggression is negative and significant in both an economic and statistical sense. The coefficient on the indicator variable for positive aggression on the part of the player is positive and statistically significant. Interestingly the coefficient on the interaction for the player is positive and statistically significant. It is immediately clear that, for this subset, there is a correlation between aggressive bidding and the impact on final salaries.

So the question then is: what do these results imply about the role player aggression plays in the arbitration process? Taking the three coefficients of interest as a whole, this implies for a player who is aggressive (has a positive aggression measure), a one standard deviation increase in their level of aggression nets a 25% lower salary. On the other hand, for a player that submits a soft offer, decreasing the offer by one standard deviation results in a 34% increase in the expected salary for that player. When taking these results into account, it seems likely that players who submit aggressive offers are impelled by a sense of risk loving behavior.

Turning my attention to the club side aggression measures, it is clear that a different economic phenomenon is driving this. The results on club aggression are also included in Table 2-6. Focusing on specification 3, the result on the raw measure of club aggression is positive and statistically significant at the 10% level, indicating, that in general as the club becomes more aggressive, players receive higher salaries. However, the other two coefficients of interest are negative and statistically significant. Taken as a whole this implies that given the club is submitting an aggressive offer, a one standard deviation increase in the offer (recall that this would be a lower submitted offer), results in a net decrease in the player's salary of 19.1%. If the club submits a soft offer this results in a positive impact on the resulting salary, although this effect is not statistically significant. If the club were submitting aggressive bids as a result of risk loving behavior, one would expect the results on aggression to have a positive impact on player salary. Instead, it is clear that aggression by the club leads to lower player salaries, suggesting that the clubs are only aggressive when they have some reliable beliefs that the arbitrators' error term is in their favor.

Table 2-7 displays the results for the same regressions but for pitchers. Focusing on the third specification: on the player's end, if they submit an aggressive offer, a one standard deviation increase in their offer results in total effect of a 40.1% reduction in expected salary. These results do match those found for position players and further supports the hypothesis that players who act aggressively do so due to their attitudes about risk. On the club side, the pattern continues. For aggressive clubs, a one standard deviation decrease in the offer results in 35.8% lower salary ex post. It is important to note that I cannot reject the hypothesis that the effects of club aggression are equal to zero.

It is necessary to take the results on pitchers with a grain of salt. The results do support the previously proposed hypothesis. However, as mentioned earlier, there are concerns about taking the implications of these results too seriously. Since there was seemingly no correlation between aggression from either party and proceeding to arbitration, it is likely that there is a missing variable involved. In addition there is basically no statistical significance on the club results.

Some general notes about the presented results are worthwhile. I tested all of the previously presented results, while also controlling for the age of the players in question. One might make a reasonable argument that even controlling for years of tenure, age might play a role in the arbitration process. That is, it is reasonable to think that older players in arbitration face the process with a greater level of risk aversion than their younger counterparts. The empirical results did not support this. Player age is not significant, statistically or economically, to the arbitration results. Furthermore, it is noteworthy that WAR does not seem to play a role in final salary based on the presented results. This occurs simply because other performance measures are also included in the right hand side of the regression. When other performance data is excluded, WAR gains statistical significance and has the expected positive correlation with salary.

Further I test the above findings by running a basic OLS regression using the ex post salary as the dependent variable and the same subset of explanatory variables, and I stratify the sample based on whether the case proceeded to arbitration or not. These results are presented in Tables 2-8 and 2-9.[16] For those players who settle before arbitration, the impact of a one standard deviation increase in the submitted

[16] Due to diminishing sample sizes, I elect to include players of both positions in these regressions. The results are the same in terms of economic significance as the results from segregating the sample, however the segregated sample loses explanatory power due to the limited sample sizes.

offer, given that their offer is over their predicted value, is a net decrease in their final salary by 29%. For those who proceed to arbitration this increases substantially. Amongst players who submit an overly aggressive bid and fail to settle prior to arbitration, a one standard deviation increase in the submitted offer results in a salary that is approximately 56% lower. I test the null hypothesis that the net effect of these coefficients is different from zero and fail to reject this hypothesis based on the F-statistic. It is notable that aggression by both players who settle and those who proceed to arbitration lead to lower salaries than their peers. Although aggressive players in both subsets suffer financially from aggressive behavior, players who proceed to arbitration suffer much more. This strongly supports the idea that aggressive players differ in their risk preferences and are willing to take on higher levels of risk through the arbitration process.

These results serve to further confirm the notion that aggressive offers on the part of clubs lead to lower salaries on the part of the players. For pairs that settle prior to arbitration, in situations in which the club submitted an aggressive offer (again below the market value), the effect of decreasing the offer by one standard deviation results in a 36.1% expected decrease in the player’s final salary. For the subset that proceeds to arbitration, an aggressive club decreasing their offer by one standard deviation results in a decrease in salary of 9.22%.

These results are perhaps more interesting than those on the player side. The fact that the level of aggression on the club side has such a large impact on the final salary if the pair settles implies that the club is good at convincing the player that their valuation of his performance is correct.[17] On the other hand, aggressive player offers actually lead to even lower salaries in the face of arbitration. This indicates that if a player is overly aggressive and proceeds to arbitration, it almost certainly not due to some knowledge about the arbitrators' error term.

In summation, these results highly favor the hypothesis that players submit high bids, not due to beliefs about the arbitrator error, but rather due to risk loving behavior. As player aggression increases, the odds of victory diminish respectively. As a result, so too does the expected salary of the player. That is, ceteris paribus, a more aggressive player faces a higher probability of losing and a lower resulting salary.

It is also noteworthy that, contrary to the patterns observed in the descriptive statistics, proceeding to arbitration has a negative impact on the players' salary all else equal. That is, given the probability of losing in arbitration, a player's expected salary is higher if he opts to settle than if he proceeds to arbitration. This is unsurprising, given that aggressive offers on the part of either party result in lower expected salaries. Although players lose a majority of arbitration cases, the increase in player ability in this subset is great enough to offset loses experienced in arbitration loses.

Finally, I run a probit to estimate the probability of a player winning in arbitration based on a set of independent variables that are similar to regressions previously presented. This regression is displayed in Table 2-10, and displays the regression coefficients. The results from this regression are somewhat limited in their ability to shed light on the causes of wins in arbitration. Of note is the result on player

[17] Anecdotally it appears that this process is also improving over time. In the early years of arbitration, many player/club pairs went to arbitration. However, 2013 was the first year since arbitration was instituted that not a single pair went to an arbitration hearing.

aggression. It is one of the few statistically significant coefficients from the regression, and clearly shows that aggressive bids on the part of players decreases their likelihood of winning in arbitration. This is as expected considering the earlier findings. Interestingly, the result on club aggression is not statistically different from zero, which indicates that club aggression does not significantly impact the win rate for players. This may be used to support the conclusion that when clubs act aggressively they are doing so on the basis of some knowledge concerning the arbitrators' tendencies. Thus, bids that appear aggressive ex ante may in reality reflect a better understanding of the arbitration panel's preferences. Again, this suggests that players bid aggressively because of risk preferences while aggressive club bids seem to be placed based on sophistication in the arbitration process.

2.4.5 Long Run Effects

It is also interesting to analyze the impact of final offer arbitration on the long run development of a player. The obvious question to as is whether the results of arbitration impact the future earnings of the player in question. Based on the data set, I am limited to looking at those who face arbitration multiple times in their careers. Arbitration is available to players during a limited window during their careers so I focus on this time period for this analysis as well. Furthermore, when players sign long-term contracts, the details of these contracts can bias the data so they are excluded from this analysis.[18] I seek to analyze how accurate arbitration is in determining a player's

[18] Multi-year contracts generally have increasing salaries. In the early years of a contract, players are often underpaid while later in the contract the player is overpaid. It makes it very difficult to analyze how arbitration impacts these players.

market value, whether players learn from the arbitration process, and whether the results of FOA impact the future earnings of the player.

I start by running baseline regressions, which are presented in Tables 2-11 and 2-12. As before, results are stratified by position. These regressions simply try to capture the impact of repeating the arbitration process through the stage of submitting offers through a basic OLS regression. Tables 2-15 (position players) and 2-16 (pitchers) show clearly that there is no statistically significant difference in terms of salary between players that had previously gone through arbitration and those who had not, regardless of position.

I next turn my attention to the impact of arbitration on the following year's negotiations. For these regressions I focus only on those players that had repeated experiences with arbitration. I test the same three specifications presented earlier. The results for players in their first year of eligibility are presented in Tables 2-13 and 2-14 while Tables 2-15 and 2-16 present those for players with previous arbitration eligibility. These results mirror those from earlier, and are not all that informative by themselves. In all situations, player aggression still has a negative impact on their final salary. Tables 2-17 and 2-18 are enlightening as they examine two specifications for salary outcomes for those players who have previously gone through arbitration process. Both specifications include basic performance indicators, as well as team and year dummies.[19] For the first specification, the variables of interest are the dummy variables that capture whether a player had proceeded to the hearing stage of arbitration in the year prior, and the result of their case in arbitration. For position players, the fact that a

[19] I did run the third specification, but all results lost statistical significance

player went through an arbitration hearing previously has no statistically significant impact on their salary results in the following year. However, if a position player won in arbitration that increased the expected salary a player would receive a year later by 40.33%. It is also important to note that the total effect of winning in arbitration is dependent on the coefficient on both the *Previous FOA* and the *Previous Arbitration Win* coefficients. The impact of a prior arbitration win on eventual salary is not statistically different (though it is economically significant) from losing in arbitration. That being said, a player's salary is almost completely predicated by their previous salary. For pitchers the results are even less remarkable. The only statistics that have statistical significance are prior salary and the player's WAR. Both of these have the expected signs, with higher measures leading to higher salaries.

I also look at how previous arbitration experience changes the effects of aggression on salary outcomes. The second specification on Tables 2-17 and 2-18 display the same results as before, but with measures of aggression for both the player and the team included. By controlling for whether a player had previously gone through arbitration, I am able to focus on whether learning occurs. When I control for previous arbitration experience, club aggression loses all significance. However, what is interesting is the change in the coefficient on player aggression. In the previous section, player aggression was associated with a negative impact on salaries. Higher bids on the part of the player tended to decrease their probability of winning in arbitration, and thus lowered their expected future salary. In both of these regressions, player aggression actually has a positive coefficient, implying that higher levels of player aggression correspond to higher salaries. This result is surprising, and suggests that players do in fact change their bidding behavior in arbitration with experience. From these regressions, it would seem that if a player has previously gone through arbitration, a higher bid indicates that the player is correctly predicting the arbitrator's preference.

Finally I examine, in retrospect, the aggression level of players considering their eventual contribution in the following year. Throughout this analysis, I have used the performance date from the previous year to predict what the player's eventual salary should be. This is how I estimated the player's true market value, and the level of aggression inherent in a player's submitted bid. However, it is possible that the player's bid represented some unobservable information. If this were the case, a player that appeared aggressive using the prior year's performance data, would, in retrospect, have deserved the high salary that he submitted in arbitration. I test this hypothesis by changing the specification in Equation 2-2. Instead of using last year's performance data, I replace it with the eventual performance data for the year in which the negotiation was concerning.

For example, assume that a player is negotiating for his eventual salary for the 1990 season. Originally I used performance data from 1989 to predict his eventual salary during the 1990 season. I refer to this as the "Ex Ante Player Aggression," as it captures his aggression using data before the season in question. I then re-examine the player using his eventual 1990 performance data and estimate his true value based on this new set of data. I can then look at his submitted offer in retrospect and measure whether his offer actually was aggressive given his eventual performance. I refer to this measure of aggression as "Ex Post Player Aggression."

Figure 2-11 presents the relationship between these two measures for pitchers while Figure 2-12 presents the same for position players. It is clear from the figures that, for position players, ex ante aggression is directly correlated with ex post aggression. That is if a player's bid originally appeared aggressive, then even when considering their eventual performance, their submitted offer was still reflected that. As Figure 2-11 shows, this is not the case for pitchers. There is no real correlation between the ex ante and ex post levels of aggression. If a pitcher appeared aggressive in his negotiations, it gives no indication concerning his eventual performance. Figure 2-13 is perhaps the most interesting figure from this analysis. It includes both pitchers and position players on the same graph. It is interesting that in retrospect all pitchers systematically bid aggressively when considering their eventual performance.

2.5 Conclusions

2.5.1 Analysis

In this paper I find evidence that suggests that in major league baseball arbitration, there are two root causes of bargaining failure: differences in risk preferences between the two parties and some knowledge about the arbitrators' tendencies on the part of ball clubs.

Across the board, aggressive bids on the part of either party increase the odds of arbitration. This result suggests that there is more at work than an unobserved variable problem (leadership, popularity, etc.) and that one of the two proposed hypotheses are driving bargaining failures.

By looking at the final impact on salaries, I attempt to dissect whether it is risk preferences or the arbitrators' estimation that is causing pairs to move to arbitration. The impact on salaries is telling. Aggression on the part of players inevitably leads to lower salaries than the players would otherwise earn. This implies that on average it is financially damaging for players to go to arbitration when they are the aggressor. The pain of losing for these players is overshadowed by the potential gains in arbitration, meaning that they willing to take on a certain level of risk for the chance at a larger payday. On the other hand, clubs tend to win a majority of arbitration hearings, and aggression by the clubs tends to also result in lower player salaries (a good thing from the clubs' perspective). When clubs are the aggressor they are not incurring any undue risk, implying that they are much better at identifying the arbitrators' preferences.

Comparing these results to previous studies is interesting. The findings of this paper tend to align with those presented in Conlin (1999). In his study, Conlin looked at signings of rookies in the National Football League (NFL), and found that the primary issue was asymmetric information being conveyed through delays (in this context holding out). His work focused on rookies, so there is a distinct lack of information regarding some of the characteristics of each player. Here it seems that clubs are more sophisticated in their understanding of the arbitration process. The findings of this paper seem to contradict the results presented in Farmer et al. They also focus on arbitration in MLB and find that false optimism is the primary cause of negotiation failure. It seems likely that the differences in results stems from two areas. First, their sample size is smaller, encompassing only 3 years of negotiations (where as this paper looks at 17). Second, the method of measuring aggression is different in the two studies (as mentioned earlier). To some extent, my findings support Farmer et al in that players tend to be overly optimistic, but I also find that clubs possess greater experience.

Additionally, the results indicate that experience with the arbitration process creates a learning opportunity for the player. When faced with arbitration for the second time, players tend to perform better. Notably, players seem to be able to more accurately bid on their value in line with the perceived value of arbitrator. It is also interesting to note that in first time negotiations, 22.02% of players fail to settle, relying on the arbitration panel to settle their dispute. When experiencing arbitration for the second time, only 7.64% of negotiations break down and end in arbitration. Clearly, repeated exposure to arbitration results in better estimates of player value on the part of those players. This also supports the hypothesis that clubs have more sophistication concerning arbitration (dealing with several players each year) while each player comes to the process with zero experience. That is, in the first time negotiations, the club is at an advantage due to their previous experiences with arbitration.

2.5.2 Notes on Further Research

This paper presents strong evidence that players are risk loving in their bids and that clubs may understand the arbitrators' decision process better. That being said, there are still questions to answer concerning the findings presented in this paper. One of the most interesting is the lack of consistent results as they relate to pitchers. It seems that obtaining statistics on the true impact of these players is much more challenging than collecting data on position players. In the future I would like to continue to look deeper at the key variables that clubs and players use to evaluate success and value of major league pitchers.

In addition, the results here, and in other papers, leave something to be desired. It is significant to show that players engage in risky behavior, but the root causes of this are still poorly understood.[20] One possible explanation is that agents play a large role in salary negotiations. In fact, it is usually the agent that decides what the player should submit as an offer and the agent handles all salary negotiations. It seems likely that for the agent, the benefits of having one customer that is awarded a generous contract outweighs the risks of having several clients settle for lower sums or lose in arbitration. This hypothesis is based on the fact that agents are typically diversified in terms of their risk, negotiating for multiple clients. It would be valuable to extend this analysis to cover the role agents play in arbitration.

[20] Wittman (1986) proposes that risk aversion plays a large role in this. He also finds that there is differing beliefs about the arbitrators probability function as it relates to optimal bids.

Table 2-1. Regression on next year's salary (pitchers)

Measure	Coefficients
Earned Runs Allowed	-0.0103713**
	(0.0050928)
Strike Outs/Inning	0.0009862**
	(0.0005379)
Outs Pitched	0.0007246***
	(0.0002335)
Wins	0.0255609***
	(0.0058689)
Losses	-0.0053309
	(0.0058829)
Saves	0.0191251***
	(0.0016827)
Wins Above Replacement	0.0346033***
	(0.0109732)
Previous Salary	0.4504465****
	(0.0165086)

All dollar figures adjusted for inflation (base year 1980)
All players eligible for arbitration but not proceeding to arbitration
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively

Table 2-2. Regression on next year's salary (position players)

Measure	Coefficients
Hits	0.0106318***
	(0.00173)
At Bats	-0.0011753***
	(0.0004359)
Batting Average	-1.246095**
	(0.5020226)
Home Runs	0.0091888***
	(0.0030858)
Runs Batted In	0.0023375*
	(0.0013625)
Stolen Bases	0.0004575
	(0.0012481)
Runs	-0.0022501
	(0.0014832)
Wins Above Replacement	0.0235355**
	(0.0094)
Previous Salary	0.4295967***
	(0.0160503)

All dollar figures adjusted for inflation (base year 1980)
All players eligible for arbitration but not proceeding to arbitration
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively

Table 2-3. Descriptive statistics

	All	Pitchers	Position
Total Sample	1568	737	831
Number Settling Prior to Submitting Offers	362	187	175
Number Settling Before Arbitration	980	441	539
Number Proceeding to Arbitration	226	109	117
Player Wins	94	41	53
Win Percentage	41.59%	37.61%	45.30%
Players Settling Prior to Arbitration (both before and after offers)	1342	629	713
Average Wins Above Replacement	1.77	1.66	1.86
Average Salary in Previous Year (Inflation Adjusted)	$539,823.20	$556,650.30	$524,978.70
Average Salary in Following Year (Inflation Adjusted)	$1,041,758	$1,052,097	$1,032,637
Players in Arbitration	226	109	117
Average Wins Above Replacement	2.14	1.94	2.33
Average Salary in Previous Year	$564,954.70	$589,028	$542,717.60
Average Salary in Following Year	$1,061,574	$1,083,361	$1,041,448

Table 2-4. Aggression measures

	Settle			Arbitration		
	All	Pitchers	Position	All	Pitchers	Position
Player Offer	$1,149	$1,161	$1,139	$1,284	$1,311	$1,260
Club Offer	$846	$854	$839	$922	$952	$895
ln(Player Offer/Club Offer)	0.33055	0.3342	0.3275	0.3887	0.3466	0.4280
	(0.1449)	(0.1473)	(0.1430)	(0.4821)	(0.1564)	(0.6517)
Disagreement/Final Salary	0.3487	0.3581	0.3410	0.4075	0.3829	0.4305
	(0.2422)	(0.2838)	(0.2020)	(0.2842)	(0.2363)	(0.3218)
Average Player "Aggression"	0.1532	0.1573	0.1499	0.2095	0.2053	0.2133
	(0.3197)	(0.3196)	(0.3200)	(0.3596)	(0.3358)	(0.3818)
Average Club "Aggression"	0.1773	0.1768	0.1777	0.1790	0.1411	0.2144
	(0.3089)	(0.3094)	(0.3087)	(0.5529)	(0.3201)	(0.7035)
n	980	440	540	226	109	117

All dollar figures adjusted for inflation (base year 1980)
All dollar figures in thousands
Only players who submitted offers
Standard Deviations in parentheses

Table 2-5. Probit on proceeding to arbitration

	All	Pitchers	Position
WAR	0.0370014*	0.0175091	0.0480096*
	(0.0237205)	(0.0402712)	(0.0288318)
ln(Previous Salary)	0.2080994***	0.241243**	0.168246
	(0.0664311)	(0.1019295)	(0.1030871)
ln(Club Payroll)	-0.1425353*	-0.1138547	-0.1467638
	(0.0787345)	(0.1186562)	(0.1232156)
Games Played	-0.0012384	-0.005274	-0.0011945
	(0.0008696)	(0.0037204)	(0.0017751)
Previously Eligible	-0.3599631***	-0.5462299***	-0.1974462
	(0.1265817)	(0.1671219)	(0.1677204)
n	1206	549	657

All dollar figures adjusted for inflation (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively

Table 2-6. Effect of aggression on salary (position players)

	Coefficients		
	Specification 1	Specification 2	Specification 3
FOA	-0.0089543	-0.0165329	-0.0175753
	(0.0583474)	(0.074338)	(0.065073)
Player Aggression	-0.2721806**	-0.471065*	-0.5756871**
	(0.127551)	(0.2612721)	(0.2864364)
Club Aggression	-0.0346723	0.165815	0.1966298
	(0.1603002)	(0.2932269)	(0.3267749)
Positive Player Aggression	-	0.3427416	0.0986086**
	-	(0.2715728)	(0.0493068)
Positive Club Aggression	-	-0.2206623	-0.1798421***
	-	(0.3182469)	(0.0569473)
Player Interaction	-	-	0.230686
	-	-	(0.2594885)
Club Interaction	-	-	-0.2075163
	-	-	(0.328783)
ln(Previous Salary)	0.9668839***	0.9733746***	0.9485707***
	(0.036004)	(0.0394683)	(0.0312606)
WAR	0.005071	0.0066267	0.0068411
	(0.0055997)	(0.0065532)	(0.0057121)
n	657	657	657

All dollar figures adjusted for inflation (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively
RHS includes suppressed variables: team dummies, year dummies, basic performance statistics, and total club payroll
2SLS method, where FOA is the instrumented variable

Table 2-7. Effect of aggression on salary (pitcher)

	Coefficients		
	Specification 1	Specification 2	Specification 3
FOA	-0.0923049*	-0.0877653*	-0.1066116**
	(0.0539759)	(0.0618969)	(0.0489964)
Player Aggression	-0.5262867***	-0.5866114***	-1.04472***
	(0.0910767)	(0.0853484)	(0.3003874)
Club Aggression	-0.3830296***	-0.3368321***	-0.4875398**
	(0.0859416)	(0.0995473)	(0.2549743)
Positive Player Aggression	-	0.0529783*	0.0941009**
	-	(0.0302741)	(0.0458325)
Positive Club Aggression	-	-0.0575273	0.0141096
	-	(0.0516369)	(0.060888)
Player Interaction	-	-	0.5493542*
	-	-	(0.3339167)
Club Interaction	-	-	0.1156761
	-	-	(0.2114779)
ln(Previous Salary)	0.9752437***	0.9901131***	0.9829609****
	(0.0295988)	(0.0289794)	(0.0245252)
WAR	-0.003667	-0.00525	-0.0061826
	(0.0121412)	(0.0108534)	(0.0130272)
n	549	549	549

All dollar figures adjusted for inflation (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively
RHS includes suppressed variables: team dummies, year dummies, basic performance statistics, and total club payroll
2SLS method, where FOA is the instrumented variable

Table 2-8. OLS results of aggression on salary-settled before arbitration

	Coefficients
Player Aggression	-1.026039***
	(0.0949925)
Club Aggression	0.145142
	(0.0905213)
Positive Player Aggression	0.0936909***
	(0.024864)
Positive Club Aggression	-0.0805733***
	(0.0256631)
Player Interaction	0.6429088***
	(0.1047946)
Club Interaction	-0.4256787***
	(0.1005723)
WAR	0.0039298
	(0.0044818)
ln(Club Payroll)	0.9922306***
	(0.0129281)
n	980

All dollar figures adjusted for inflation (base year 1980)
Standard Deviations in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively

Table 2-9. OLS results of aggression on salary-proceed to arbitration

	Coefficients
Player Aggression	-0.2573051
	(0.1705686)
Club Aggression	-0.5785909***
	(0.1976655)
Positive Player Aggression	0.0937944
	(0.0596224)
Positive Club Aggression	-0.1173254**
	(0.058045)
Player Interaction	-0.4035569*
	(0.2122052)
Club Interaction	0.6035504***
	(0.2023898)
WAR	0.0148271
	(0.0106591)
ln(Club Payroll)	1.005632***
	(0.0308559)
n	226

All dollar figures adjusted for inflation (base year 1980)
Standard Deviations in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively

Table 2-10. Probit on arbitration win

	Coefficients
Player Aggression	-2.023925*
	(1.127511)
Club Aggression	0.0814532
	(1.066379)
Positive Player Aggression	0.5638334*
	(0.3339948)
Positive Club Aggression	-0.1281031
	(0.3095629)
Player Interaction	1.622938
	(1.316097)
Club Interaction	0.2062959
	(1.102152)
ln(Previous Salary)	-0.1365711
	(0.1674433)
WAR	0.1122401**
	(0.0572761)
n	226

All dollar figures adjusted for inflation (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively

Table 2-11. Effect of previous eligibility on salary (position players)

	Coefficients
Previously Eligible	-0.0078751
	(0.0308681)
ln(Previous Salary)	0.4310214***
	(0.0193066)
WAR	0.0435719***
	(0.0091771)
n	657

All dollar figures inflation adjusted (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively
RHS includes suppressed variables: team dummies, year dummies, basic performance statistics, and total club payroll

Table 2-12. Effect of previous eligibility on salary (pitchers)

	Coefficients
Previously Eligible	0.0507193
	(0.0361006)
ln(Previous Salary)	0.4467333***
	(0.019557)
WAR	0.0361277***
	(0.0120997)
n	549

All dollar figures adjusted for inflation (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively
RHS includes suppressed variables: team dummies, year dummies, basic performance statistics, and total club payroll

Table 2-13. Effect of aggression on salary for position players (first time eligible)

	Coefficients		
	Specification 1	Specification 2	Specification 3
FOA	-0.0955527	-0.074518	-0.0773209
	(0.0616601)	(0.0630046)	(0.070809)
Player Aggression	-0.1865782	-0.3646936**	-0.4584114*
	(0.1675236)	(0.1495313)	(0.268485)
Club Aggression	-0.0104027	0.0211068	0.0673434
	(0.2048338)	(0.1782251)	(0.3407464)
Positive Player Aggression	-	0.0728127*	0.0784141*
	-	(0.0440209)	(0.0448167)
Positive Club Aggression	-	-0.1862872***	-0.177883**
	-	(0.0588974)	(0.0787859)
Player Interaction	-	-	0.1481626
	-	-	(0.2350545)
Club Interaction	-	-	-0.0517805
	-	-	(0.4070716)
ln(Previous Salary)	0.977188***	0.9629007***	0.9627444***
	(0.0367754)	(0.0338343)	(0.0325452)
WAR	0.0027215	0.0047027	0.0055873
	(0.0065197)	(0.0075192)	(0.0071054)
n	386	386	386

All dollar figures adjusted for inflation (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively
RHS includes suppressed variables: team dummies, year dummies, basic performance statistics, and total club payroll
2SLS method, where FOA is the instrumented variable

Table 2-14. Effect of aggression on salary for pitchers (first time eligible)

	Coefficients		
	Specification 1	Specification 2	Specification 3
FOA	-0.1296209**	-0.1016684*	-0.1151041**
	(0.0606308)	(0.0618304)	(0.0564789)
Player Aggression	-0.5374218***	-0.6309984***	-1.273441***
	(0.1545337)	(0.1617003)	(0.4069834)
Club Aggression	-0.3845189	-0.3279044**	-0.4654637
	(0.1603002)	(0.1597313)	(0.3013638)
Positive Player Aggression	-	0.0874447**	0.1454445*
	-	(0.0444014)	(0.0761139)
Positive Club Aggression	-	-0.0876203	0.028355
	-	(0.0833646)	(0.0651448)
Player Interaction	-	-	0.8264706**
	-	-	(0.3878632)
Club Interaction	-	-	0.0753213
	-	-	(0.276501)
ln(Previous Salary)	0.9539102***	0.9314045 ***	0.9362801***
	(0.0693879)	(0.0524457)	(0.0312606)
WAR	0.0072043	-0.0066267	-0.0089554
	(0.018852)	(0.0174588)	(0.0195232
n	325	325	325

All dollar figures adjusted for inflation (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively
RHS includes suppressed variables: team dummies, year dummies, basic performance statistics, and total club payroll
2SLS method, where FOA is the instrumented variable

Table 2-15. Effect of aggression on salary for position players (previous arbitration experience)

	Coefficients		
	Specification 1	Specification 2	Specification 3
FOA	0.0480893	0.001175	0.0173141
	(0.0924152)	(0.0879957)	(0.0757816)
Player Aggression	-0.6349323***	-0.8245004***	-1.044922***
	(0.1399038)	(0.1529578)	(0.4239069)
Club Aggression	-0.1399038	-0.1388655	-0.4875697**
	(0.1908381)	(0.1173859)	(0.3820407)
Positive Player Aggression	-	0.1711613***	0.0941211**
	-	(0.0615038)	(0.0786826)
Positive Club Aggression	-	-0.1923303***	0.0140736
	-	(0.065705)	(0.0694529)
Player Interaction	-	-	0.5492099**
	-	-	(0.4321869)
Club Interaction	-	-	0.1155767
	-	-	(0.3931602)
ln(Previous Salary)	0.9670778***	0.9412129***	0.9829799***
	(0.0492729)	(0.0446361)	(0.0519432)
WAR	0.0190835	0.0134558	0.0164356
	(0.0104736)	(0.0091548)	(0.0108469)
n	271	271	271

All dollar figures adjusted for inflation (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively
RHS includes suppressed variables: team dummies, year dummies, basic performance statistics, and total club payroll
2SLS method, where FOA is the instrumented variable

Table 2-16. Effect of aggression on salary for pitchers (previous arbitration experience)

	Coefficients		
	Specification 1	Specification 2	Specification 3
FOA	0.0142575	-0.0164354	-0.0106797
	(0.0543609)	(0.0459851)	(0.057073)
Player Aggression	-0.4963667***	-0.4922774***	-0.3824814**
	(0.0764317)	(0.1031582)	(0.1581808)
Club Aggression	-0.3985157***	-0.3818725***	-0.539979**
	(0.1063478)	(0.1156553)	(0.2298155)
Positive Player Aggression	-	-0.000301	0.0173361
	-	(0.0255624)	(0.038946)
Positive Club Aggression	-	-0.0116093	-0.0126299
	-	(0.0484071)	(0.0565578)
Player Interaction	-	-	-0.1651021
	-	-	(0.2221794)
Club Interaction	-	-	0.2423615
	-	-	(0.2432207)
ln(Previous Salary)	0.9803917***	0.9804944***	0.9767609***
	(0.0220004)	(0.0222316)	(0.0265608)
WAR	0.0029575	0.0028387	0.0015766
	(0.01064)	(0.009138)	(0.0082455)
n	224	224	224

All dollar figures adjusted for inflation (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively
RHS includes suppressed variables: team dummies, year dummies, basic performance statistics, and total club payroll
2SLS method, where FOA is the instrumented variable

Table 2-17. Effect of aggression and previous arbitration results on salary for position players

	Coefficients	
	Specification 1	Specification 2
Previous FOA	-0.1592781	-0.2395665*
	(0.1562652)	(0.1427241)
Previous Arbitration Win	0.4033469*	0.4000657*
	(0.2411221)	(0.2191116)
Player Aggression	-	0.5192629**
	-	(0.214268)
Club Aggression	-	0.119796
	-	(0.2229984)
ln(Previous Salary)	0.5057452***	0.4328132***
	(0.0585328)	(0.0580183)
WAR	0.0608812**	0.0491156**
	(0.0243444)	(0.0222778)
n	161	161

All dollar figures adjusted for inflation (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively
RHS includes suppressed variables: team dummies, year dummies, basic performance statistics, and total club payroll
2SLS method, where FOA is the instrumented variable

Table 2-18. Effect of aggression and previous arbitration results on salary for pitchers

	Coefficients	
	Specification 1	Specification 2
Previous FOA	0.0065008	0.0150386
	(0.1041859)	(0.0867301)
Previous Arbitration Win	-0.164918	-0.1442717*
	(0.1591255)	(0.1323223)
Player Aggression	-	0.5565069***
	-	(0.1586796)
Club Aggression	-	0.0722263
	-	(0.1821896)
ln(Previous Salary)	0.6774997***	0.6185406***
	(0.0469942)	(0.0467345)
WAR	0.0334795*	0.0320927**
	(0.0185982)	(0.0154979)
n	114	114

All dollar figures adjusted for inflation (base year 1980)
Standard Errors in parentheses
*, **, *** Represents statistical significance at the 10%, 5%, and 1% level respectively
RHS includes suppressed variables: team dummies, year dummies, basic performance statistics, and total club payroll
2SLS method, where FOA is the instrumented variable

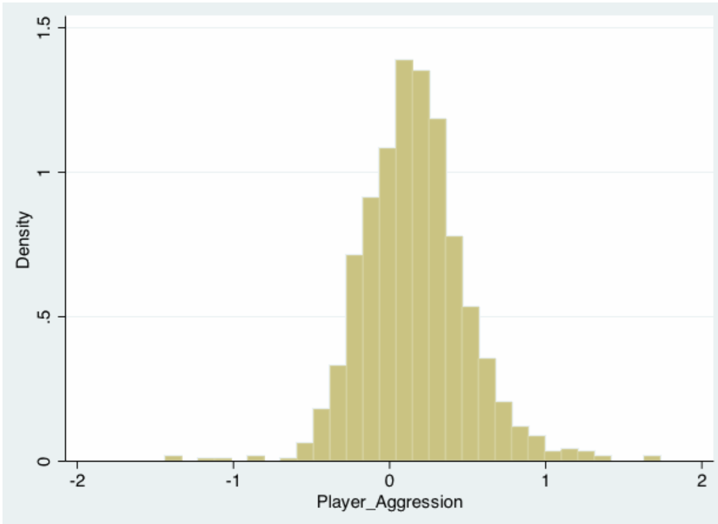

Figure 2-1. Player aggression

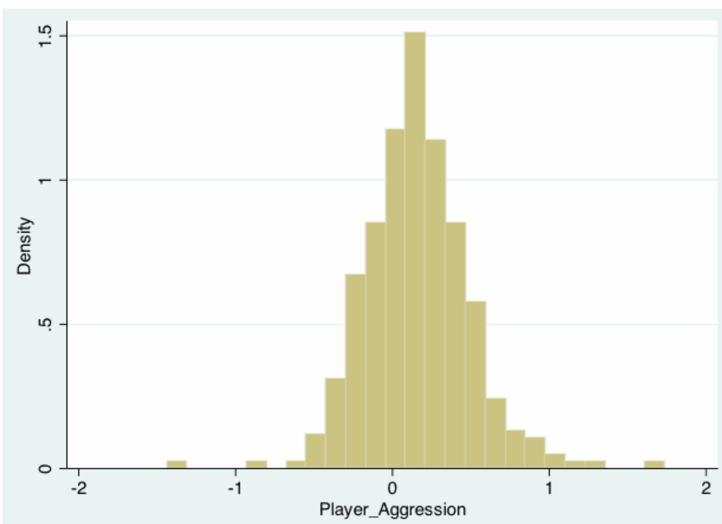

Figure 2-2. Player aggression (position players)

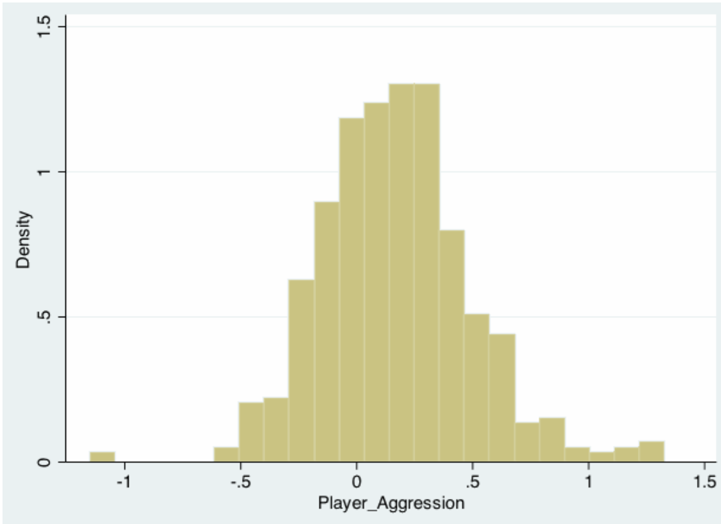

Figure 2-3. Player aggression (pitchers)

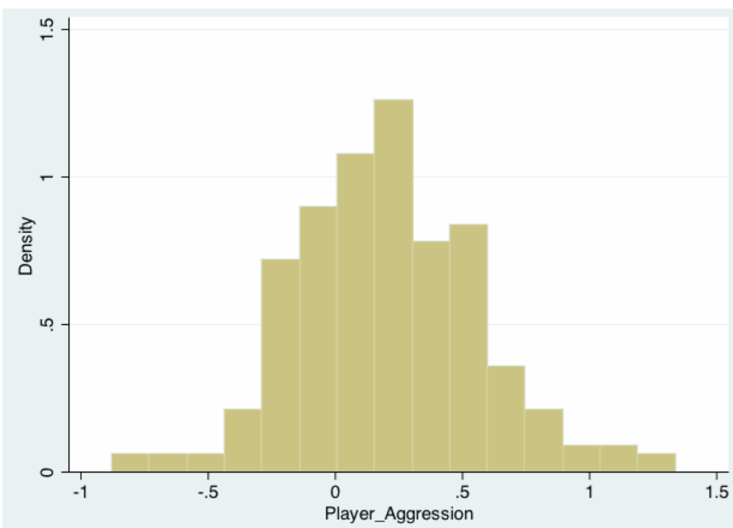

Figure 2-4. Player aggression (players proceeding to arbitration)

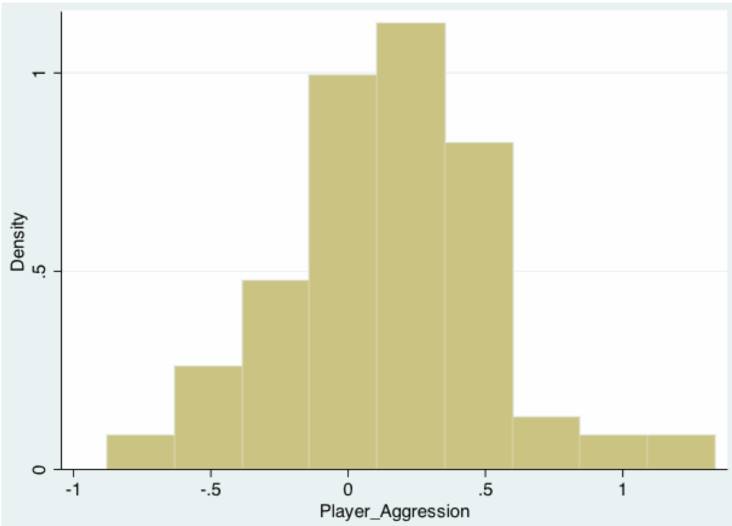

Figure 2-5. Player aggression (players winning in arbitration)

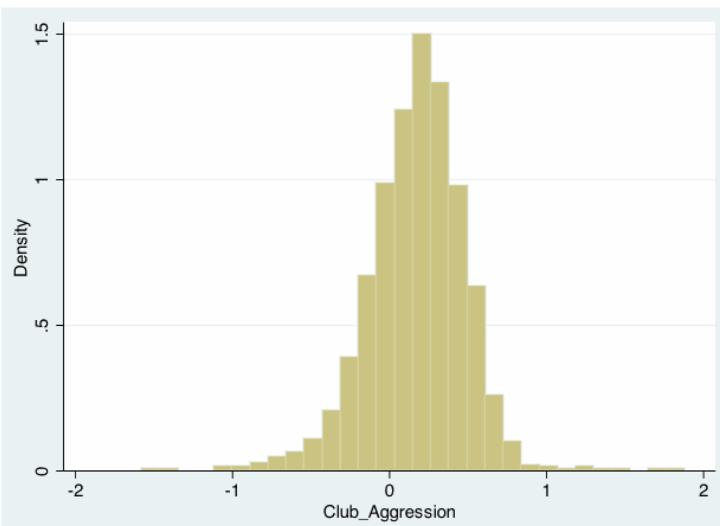

Figure 2-6. Club aggression

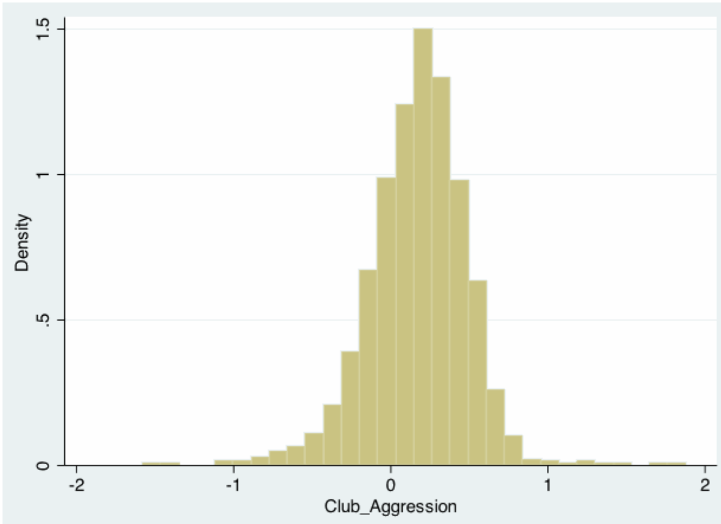

Figure 2-7. Club aggression (position players)

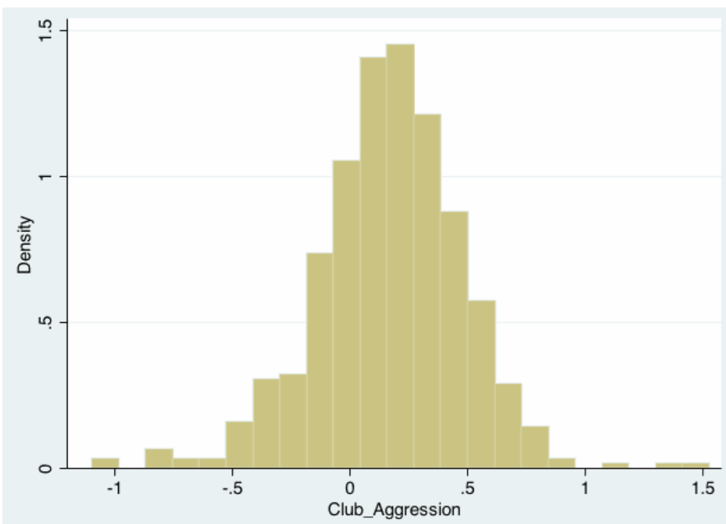

Figure 2-8. Club aggression (pitchers)

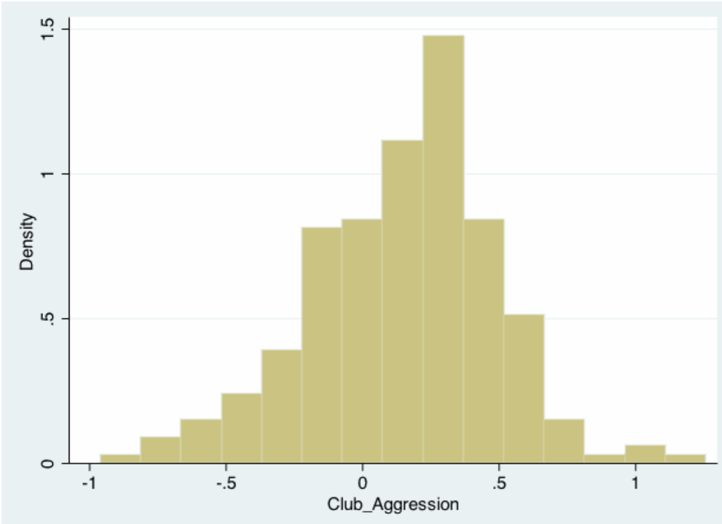

Figure 2-9. Club aggression (players proceeding to arbitration)

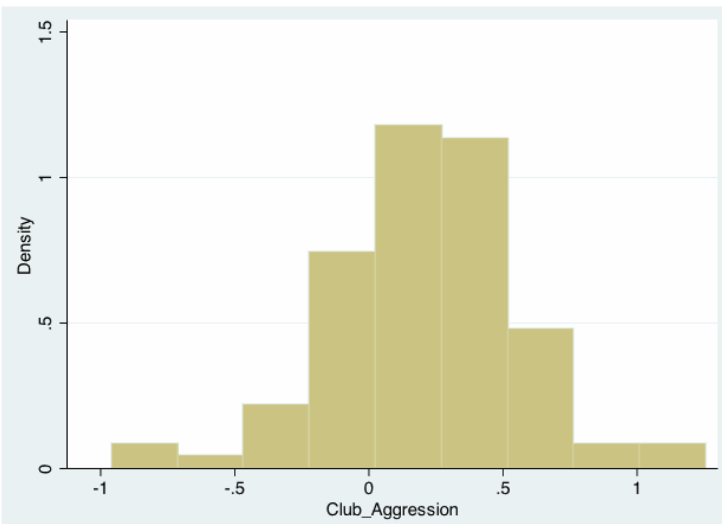

Figure 2-10. Club aggression (players winning in arbitration)

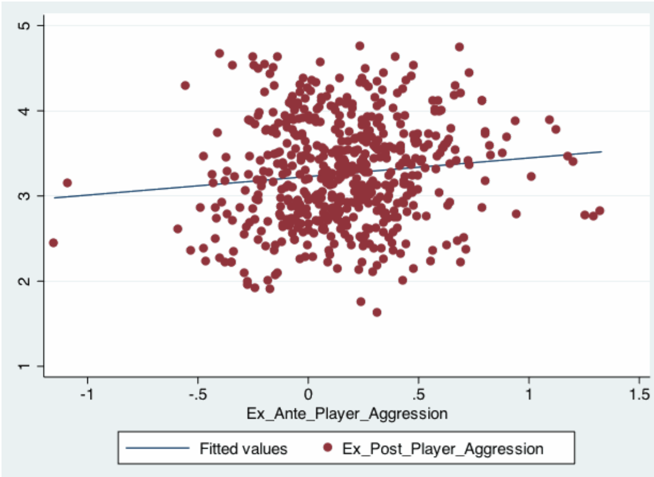

Figure 2-11. Ex ante v. ex post player aggression (pitchers)

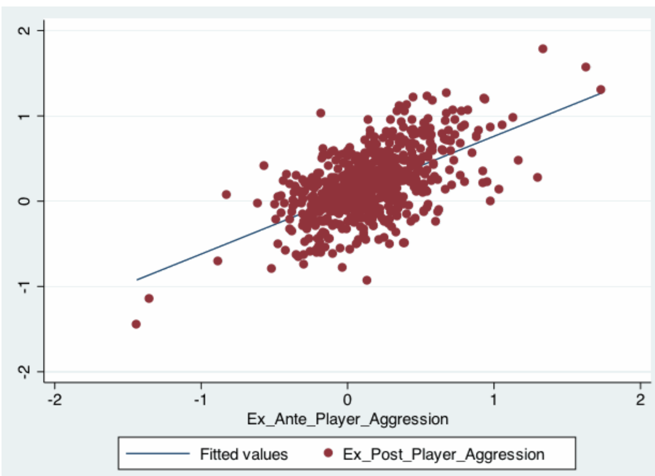

Figure 2-12. Ex ante v. ex post player aggression (position players)

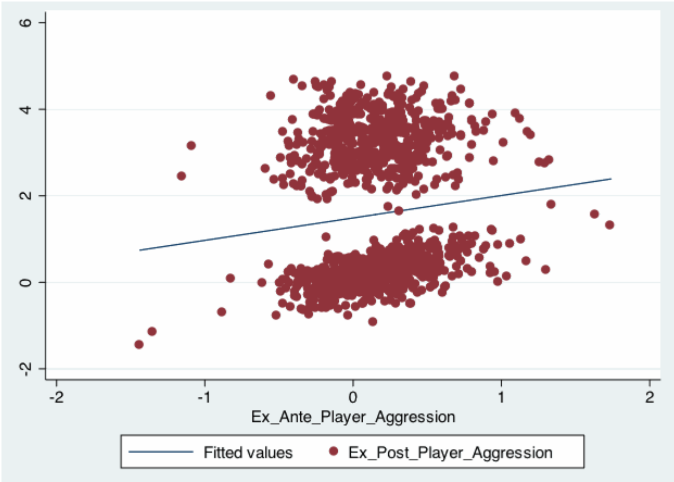

Figure 2-13. Ex ante v. ex post player aggression (all players)

APPENDIX A
SPECIFICATIONS OF SALARY REGRESSIONS

List of all variables included in the aggression estimates. Player-specific variables are unique to the player in a given year. Club variables are the same for all players in a given year but can vary from year to year.

Position Players:

Games played, at bats, runs, hits, runs batted in, home runs, stolen bases, on base percentage

Pitchers:

Games played, wins, losses, shut outs, saves, total outs pitched, strike outs, earned runs allowed

Other Player Statistics:

Ln(Previous Salary), Wins Above Replacement (WAR), previously eligible for arbitration, years of experience

Club-Specific:

Ln(Club Payroll), Attendance

Dummy Variables:

Year, player type (pitcher or fielder), team, submitted offer, player won/lost arbitration

APPENDIX B
DESCRIPTION OF WINS ABOVE REPLACEMENT

General Formula:

Runs Over Replacement = Player Runs – Replacement Player Runs

This value for runs is then used in a win estimation formula to predict the wins for a team with the particular player on the team.

Position Players:

Batting Runs – based on a particular season. Looks at runs generated from batting while taking into account reaching base on errors while ignoring runs generated/lost from base running

Baserunning Runs – looks at stolen base versus caught stealing as well as taking more than expected bases from singles. Factors in the base on which a base runner begins versus where they end up at the end of a play where ball is put into play

Grounded into Double Play – takes into account how skilled a player is at avoiding double plays

Defensive Runs – takes into account range of player as well as the impact they have on preventing runs from being scored

Positional Adjustments – accounts for the position at which player spends primary playing time

Replacement Level – determined by the predicted stats of a team with a 0.34 winning percentage

Pitchers:

Runs Allowed – accounts for both earned and unearned runs

Innings Pitched – accounts for how many innings pitcher was playing

* Controls in place for quality of opponent, team’s defense, ballpark, and role of pitcher

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