Indentured servitude is modeled as a trans-Atlantic market in forward-labor contracts. The model is applied to servant-auction evidence in Philadelphia, and the determinants of contract prices are used to test the efficient-market hypothesis. While competing for servants in Europe, most of the expected price differences across servants were lost through arbitrage by recruiters.

Indentured servitude played an important role in European migration to North America in the seventeenth and eighteenth centuries. Emigrants attracted by the opportunities in America but too poor to afford the voyage could trade contracts on their future labor for passage fare to America before leaving Europe. Shippers would carry these immigrants and their labor contracts across the Atlantic and sell them to recover voyage expenses. By guaranteeing the contract terms to the servant before sailing these shippers were essentially speculating in forward-labor contracts. As late as the American Revolution the majority of European immigrants may have voluntarily used servitude to pay for the journey. Indentured immigration was one of the most important private-market solutions to financing the colonial migration of poor Europeans.
Indentured immigration was a trans-Atlantic market in forward-labor contracts. Forward contracting distinguished this market from other forms of long-term contracting. The important issue in forward contracting is how well it conforms to the efficient-market hypothesis, or how well future values are estimated and how efficiently the value of information is arbitrated when negotiating the initial contract. The analysis that follows will model and test whether the market for indentured immigrants conformed to the efficient-market hypothesis.

Previous economic studies of colonial indentured immigration have ignored the issues of forward contracting and efficient forecasting and instead have favored use of the market to evaluate human capital. For example, Robert Heavner analyzed the auction of servants after they arrived in Philadelphia and used the variance in contract prices as the sole measure of differences in servant human capital. He modeled indentured immigration as a spot market and ignored the effect that competitive recruiting of servants in Europe would have on their subsequent colonial prices.

By contrast, David Galenson analyzed recruitment of indentured servants in England and used the variance in contract lengths negotiated prior to sailing as the primary measure of differences in servant human capital. He assumed that recruiters in Europe competed away all expected contract price differences in the colonies by altering the contract terms offered servants, principally the amount of service time, until their expected colonial value just equaled their shipping cost. The
shipping cost was assumed to be constant across servants, therefore, the expected colonial price would be constant across servants.

In effect, Galenson invoked the efficient-market hypothesis to assume that colonial auction prices had no additional information with respect to measuring human capital, and he used this to justify the absence of contract prices in his regression analysis. However, if recruiters in Europe did not forecast the future colonial prices of their servants with perfect efficiency, then the relationship between contract length and the value of servant human capital would be broken. Therefore, Galenson’s conclusions depend critically on how well the market conformed to the efficient-market hypothesis.

At first glance, evidence on contract prices in the colonies does not support the efficient arbitrage of all price differences. For example, indentured immigrant prices in Philadelphia, the largest and most developed servant market in eighteenth-century North America, exhibited considerable variance, see Table 1. The standard error in prices was around 16 to 22 percent of the mean price, and female prices were below male prices. The price distribution was similar to that of contract lengths, suggesting that price variance was as important as contract length variance in explaining servant values.

However, the evidence also suggests that indentured immigration was not a spot market and that competitive recruiting in Europe had some effect on subsequent colonial prices. The positive relationship between service time and contract price, expected in a spot market, was not very evident. The correlation coefficient between contract price and length was \(-.06\) in the 1745 sample and \(.25\) in the 1771 to 1773 sample.\(^7\) Secondly, 15 Pennsylvania pounds equalled about 8.6 pounds sterling in 1745 and 9.3 pounds sterling in 1772.\(^8\) The range encompassed the costs incurred in recruiting, equipping, and transporting servants.\(^9\) This finding suggests excessive profits may have been competed away in the recruiting process.\(^10\)

\(^7\) The coefficients were significant at the .15 and .001 levels for the 1745 and 1771 to 1773 samples.


\(^9\) See Smith, *Bondage*, pp. 35–39; Galenson, *White Servitude*, pp. 251–52; Mildred Campbell, “English Emigration on the Eve of the American Revolution,” *American Historical Review*, 61 (Oct. 1955), p. 17; and R. J. Dickson, *Ulster Emigration to Colonial America 1718–1775* (London, 1966), pp. 86–87. The freight cost was around 3.5 to 6 pounds sterling. Adding in recruiting and equipping costs could raise the amount to 10 or 12 pounds sterling. These estimates of shipping costs may not include returns to uncertainty or risk caused by servant default due to death or disease which could cause the estimated cost of shipping servants to increase even more.

\(^10\) Profits in the indentured immigrant trade can not be directly estimated with this evidence because the cost of shipping servants was not recorded and the risk of servant default through death, disease, and escape is unknown. For a systematic effort to estimate the profits from shipping redemptioner servants see Farley Grubb, “Risk and the Rate of Return to Financing the Immigration of German Servants to Philadelphia,” paper presented at the annual meeting of the Economic History Association, Sept. 1985 (mimeo).
TABLE I
PRICES AND LENGTHS OF BRITISH IMMIGRANT INDENTURE CONTRACTS
IN PHILADELPHIA, 1745 AND 1771–1773

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
<th>Average Contract Price</th>
<th>Average Contract Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1745</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>432</td>
<td>15.50 (2.57)</td>
<td>4.44 (1.05)</td>
</tr>
<tr>
<td>Females</td>
<td>66</td>
<td>13.23 (2.71)</td>
<td>4.14 (0.68)</td>
</tr>
<tr>
<td>1771–1773</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>584</td>
<td>15.22 (3.28)</td>
<td>4.13 (1.08)</td>
</tr>
<tr>
<td>Females</td>
<td>248</td>
<td>13.42 (2.11)</td>
<td>3.97 (0.72)</td>
</tr>
</tbody>
</table>

Notes: Standard errors are in parentheses. Contract prices are in Pennsylvania pounds and contract lengths are in years.


Although Table I does not offer much support for the efficient-market hypothesis, it does not rule it out. The efficient-market hypothesis is a statement about expected prices, not actual prices. Efficient forecasting does not mean perfect price prediction. Many unpredictable events may have intervened between contract formation in Europe and subsequent sale in the colonies. For example, colonial labor-market conditions may have changed unexpectedly between recruitment in Europe and delivery in the colonies, particularly given the four to six months it took information to make the round trip across the Atlantic. The rigors of the voyage may have also altered expected servant productivity. Thus shippers may have found the value of the indentures in their possession unexpectedly changed before the colonial auction. Such events may have introduced price variance into colonial-servant auctions.

The presence of substantial risks for merchants speculating in forward-labor contracts does not imply that the market was inefficient. Risks were information costs that affected decisions just like any other cost. The presence of risks makes measuring the efficiency of the market difficult. A model of indentured immigration must separate predictable from unpredictable sources of price variance to measure the degree to which the market conformed to the efficient-market hypothesis. Such a procedure will also help determine whether the variance in contract prices or contract lengths best measured the differences in servant human capital.

The evidence used to test the model was taken from the indentured

portion of the Philadelphia immigrant servant market for the years 1745 and 1771 to 1773. The sample contained over 1,300 separate contract sales. Philadelphia possessed a large and active market in contract labor, perhaps the single largest in eighteenth-century North America. Colonies south of Pennsylvania had shifted to reliance on slave labor by the eighteenth century, and colonies north of Pennsylvania never attracted many immigrant servants. Buyers from as far away as South Carolina, New Hampshire, and Kentucky purchased servants in Philadelphia. The Philadelphia market was also unique among North American colonies in that civil authorities periodically recorded the salient features of each servant sale.

THE MODEL OF INDENTURED IMMIGRATION

Indentured immigration is modeled as a competitive trans-Atlantic market for forward-labor contracts. The first half of the model, outlined in Table 2, involves the recruitment market for servants in Europe where all the contract parameters were determined. Competitive equilibrium in the shipping market, equation 1, implies that recruiters bid for servants until the expected colonial contract price of each servant just equaled the cost of delivering that servant, thus yielding zero economic profits. The price European recruiters expected to receive for the servants in the colonies depends on their forecast of the net value of the colonial productivity of their servants over the

12 The Philadelphia records included contracts for resident servants and apprentices as well as for immigrant indentured and redemptioner servants. Indentured immigrants were distinguished from redemptioners by the fact that indenture sales were contract transfers and so “assigned” by a seller, other than the servant himself, to a buyer. Redemptioner contracts were formed on the spot directly by the servant. Indentured contracts commenced upon arrival in port whereas redemptioner contracts commenced upon sale. In the 1745 records roughly 87 percent of the immigrant servants used the indenture method and in the 1771 to 1773 records roughly 30 percent used the indentured method. Residents and immigrants were separated by the references to the origin of the servant. All of the indentured immigrants in the 1745 sample were Irish. About 12.6 percent of the 840 indentured immigrants in the 1771 to 1773 sample were English with the rest being Irish. Although Irish and German immigrants each accounted for about 40 percent or more of all servants arriving in this period, Germans used the redemptioner method exclusively and so do not appear in this study.


14 For the geographic distribution of purchasers of immigrant servants who arrived in Philadelphia see Grubb, “Immigrant Servant Labor.”

15 The European recruitment of indentured servants appears to have been competitive, see Galenson, White Servitude, pp. 97–98; and Smith, Bondage, pp. 1–18. The sale of indentured
## Table 2

### A MODEL OF INDENTURED IMMIGRATION

#### I. The European Recruitment Market

**Competitive Equilibrium in the Shipping Market:**

\[ DC = E(CP) \] (1)

**Contract Formation Asset Pricing Equations:**

\[ E(CP) = \int_0^T E(VNP) \exp(-rt) \, dt \] (2)

\[ E(VNP) = f(H,K) \] (3)

**Competitive Equilibrium in the Recruitment Market:**

\[ DC = \text{constant} = E(CP) = g(T,H,K,r) \] (4)

#### II. The Colonial Market Auction

**The Efficient Market Hypothesis:**

\[ CP = E(CP) + PRI + \text{random error} \] (5)

\[ CP = \text{constant} + g(T,H,K,r) + PRI + \text{random error} \] (6)

**Specification Estimated:**

\[ \ln(CP) = \text{constant} + a_1 \ln \left( \frac{1 - \exp(-rT)}{r} \right) + a_2 H + a_3 K + b_1 PRI + \text{random error} \] (7)

Where:

- \( E(CP) \) = expectation at the time of recruitment in Europe of the future colonial contract price.
- \( DC \) = delivery cost which is assumed constant across servants, and not a function of \((T,H,K,r)\).
- \( E(VNP) \) = expectation at the time of recruitment in Europe of the future value of the net productivity of servants in the colonies.
- \( T \) = contract length determined in Europe.
- \( r \) = discount rate.
- \( H \) = a vector of all servant characteristics observed at the time of recruitment in Europe.
- \( K \) = a vector of all contract parameters other than contract length determined at the time of recruitment in Europe.
- \( CP \) = actual contract price in the colonies.
- \( PRI \) = a vector of post-recruitment information which was unpredictable at the time of contract formation in Europe.
- \( a, b \) = estimating coefficients.

The length of the contract, continuously discounted, equation 2. The expected net value of servant productivity is a function of fixed servant traits and contract parameters, other than length, observed at the time of recruitment in Europe, equation 3. Finally, the evidence suggests that servants in Philadelphia also appears to have been competitive. The 1745 sample had around 500 servants, delivered on over 30 ships, and marketed by over 75 agents. The 1771 to 1773 sample had around 840 servants, delivered by over 40 ship captains, and marketed by an even greater number of agents. No colonial buyer purchased over 1 percent of the servants in either sample. A direct example of the spirited competition for immigrant cargoes can be seen in the transportation contract signed by 26 Germans going from Rotterdam to Philadelphia in 1756. Isaac and Zacharias Hope, major recruiters in Rotterdam, contracted to ship these Germans for 7.5 doblons each, but within the contract was also written the following condition: "But if anyone agrees to take these Germans for less than the above-mentioned sum, Messrs. Isaac & Zacharias Hope promise to do the same, except where it is plainly done as spite work against Messrs. Isaac & Zacharias Hope, in which case they release the people from the contract, however in such case those who offer cheaper transportation are to pay Messrs. Isaac & Zacharias Hope for the expenses which they incurred before the people arrived in port." Otto Langguth, "Pennsylvania German Pioneers from the County of Wertheim, Pennsylvania German Folklore Society, 12 (1947), pp. 260–61.

the delivery cost was constant across all adult servants, which yields equation 4, the competitive equilibrium in the European recruitment market. After considering the characteristics and expected colonial value of each servant, the recruiter while in Europe would adjust the negotiable contract terms through competitive bidding until each servant was expected to sell for the same price in the colonies, just enough to cover the cost of delivery. The model of the European half of the market is basically consistent with the Galenson analysis.

The second half of the market, also outlined in Table 2, is the colonial auction where the actual contract price was determined. The efficient-market hypothesis, equation 5, is formulated by separating the actual price into the part expected at the time of recruitment in Europe, the part due to unpredictable changes occurring between European recruitment and colonial sale, and an error term. Substituting the expressions for the expected contract price from equation 4 into equation 5 yields equation 6 which will allow testing of the efficient-market hypothesis.

Because the expected contract price is already embodied in the constant term, all the information that went into formulating the expected contract price (the $g$ function) should add nothing to the explanation of the variance in actual contract prices. Efficiency implies that the estimated coefficients on the terms in the $g$ function should be jointly insignificant. Significant coefficients on any of the $g$ terms will indicate areas in which recruiters experienced forecasting difficulties. The particular specification estimated, equation 7, is a double-log version of equation 6 where $H$, $K$, and $PRI$ are modeled as multiplicative exponential vectors in the asset-pricing equation. Efficiency under this specification entails that the $a$ coefficients be jointly insignificant and that the error term be random.

**EMPIRICAL RESULTS**

Equation 7 was estimated using the indentured-immigrant portion of the contract sales recorded for the port of Philadelphia in the years 1745 and 1771 to 1773. In these years the civil authorities recorded the salient features of each contract sale: the price, date of sale, date of contract

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17 Evidence on passenger fare structures for the late eighteenth century is scarce. However, the existing evidence indicates that all adult servants above age twelve on a given ship were charged the same fare; see the fares charged on the ships Belvidere, Commerce, Pennsylvania, and Elizabeth recorded in Ralph B. Strassburger, Pennsylvania German Pioneers, William J. Hinke, ed., (Norristown, Pa., 1934), vol. 3, pp. 112–14, 131–34, 137–38; and “Passenger List of the Ship ‘Elizabeth’, Which Arrived at Philadelphia in 1819,” Pennsylvania Magazine of History and Biography, 25 (1901), pp. 255–58. The impression of a constant fare structure across adults is also conveyed in immigrant diaries. See for example Julius F. Sachse, “A Missive From Pennsylvania in the Year of Grace 1728,” Pennsylvania German Society, 28 (1909), p. 18; Gottlieb Mittelberger, Journey to Pennsylvania in the Year 1750 and Return to Germany in the Year 1754, (Cambridge, Mass., 1960), p. 17; and Strassburger, Pioneers, vol. 1, p. xxxvii. This structure of passage fares is also used by Galenson in his model, see fn. 6.

18 Galenson, see fn. 6, extends the model by assuming that contract length was the only parameter adjusted to reach equilibrium in the recruitment market.
TABLE 3
CONTRACT PRICE DETERMINATION IN THE PHILADELPHIA MARKET FOR INDENTURED IMMIGRANTS, 1745 AND 1771-1773

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Number of Cases</th>
<th>1745 Coefficients</th>
<th>Number of Cases</th>
<th>1771-1773 Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>498</td>
<td>2.7131***</td>
<td>840</td>
<td>5.2488</td>
</tr>
<tr>
<td>ln \left( \frac{1 - \exp(-rT)}{r} \right)</td>
<td>498</td>
<td>0.0652</td>
<td>840</td>
<td>0.3454***</td>
</tr>
<tr>
<td><strong>K Vector</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training provided</td>
<td>17</td>
<td>0.0350</td>
<td>5</td>
<td>0.2032**</td>
</tr>
<tr>
<td>Employed at a skilled trade</td>
<td></td>
<td></td>
<td></td>
<td>(.1031)</td>
</tr>
<tr>
<td>Extra freedom dues</td>
<td>5</td>
<td>0.0485</td>
<td>3</td>
<td>-0.0475</td>
</tr>
<tr>
<td>No freedom dues</td>
<td>1</td>
<td>-0.5604*</td>
<td></td>
<td>(0.2948)</td>
</tr>
<tr>
<td>Servant as his own marketing agent</td>
<td>26</td>
<td>-0.0389</td>
<td></td>
<td>(0.0787)</td>
</tr>
<tr>
<td>Sold by the ship's captain</td>
<td></td>
<td></td>
<td>675</td>
<td>-0.0055</td>
</tr>
<tr>
<td><strong>H Vector</strong></td>
<td></td>
<td></td>
<td></td>
<td>(0.1609)</td>
</tr>
<tr>
<td>Females (unmarried)</td>
<td>66</td>
<td>-0.1549***</td>
<td>248</td>
<td>-0.9680***</td>
</tr>
<tr>
<td>Married with a joint contract</td>
<td>8</td>
<td>-0.1096*</td>
<td></td>
<td>(0.0822)</td>
</tr>
<tr>
<td>Time of Arrival Year</td>
<td></td>
<td></td>
<td>840</td>
<td>-0.0016</td>
</tr>
<tr>
<td>(10^{-4} \times \text{the order of sale})</td>
<td>498</td>
<td>0.3000</td>
<td></td>
<td>(-0.9000)</td>
</tr>
<tr>
<td>Fall</td>
<td>224</td>
<td>0.0391*</td>
<td>237</td>
<td>0.0007</td>
</tr>
<tr>
<td>Winter</td>
<td>14</td>
<td>0.0252</td>
<td></td>
<td>(0.0227)</td>
</tr>
<tr>
<td>Spring</td>
<td>75</td>
<td>0.1140**</td>
<td></td>
<td>(0.0367)</td>
</tr>
<tr>
<td>Summer</td>
<td></td>
<td></td>
<td>302</td>
<td>-0.0189</td>
</tr>
<tr>
<td>Port of Departure</td>
<td></td>
<td></td>
<td></td>
<td>(0.0215)</td>
</tr>
<tr>
<td>Ulster</td>
<td>246</td>
<td>-0.0322*</td>
<td></td>
<td>(0.0244)</td>
</tr>
<tr>
<td>South Ireland</td>
<td>247</td>
<td>-0.0316*</td>
<td></td>
<td>(0.0239)</td>
</tr>
<tr>
<td>Bristol</td>
<td>65</td>
<td>0.2051***</td>
<td></td>
<td>(0.0347)</td>
</tr>
<tr>
<td>London</td>
<td>41</td>
<td>0.1083***</td>
<td></td>
<td>(0.0406)</td>
</tr>
<tr>
<td><strong>PRI Vector</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26 additional variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(R^2\) .131 .277
Corrected \(R^2\) .094 .257
\(F\)-statistic 2.62*** 13.59***
Durbin-Watson statistic 2.02 1.88
Number of observations 498 840
commencement, origins of the servant, contract length, any other special contract stipulations, the names of the principals to the transac- tion, and the residence of the colonial purchaser. Many of these variables were not common to both bodies of evidence, and separate regressions were performed on each sample. The description of the

* Indicates significance above the .2 level.
** Indicates significance above the .05 level.
*** Indicates significance above the .001 level.

Includes variables relating to the time needed to sell the contract in the colonies and the geographic residence of the purchaser. The results and interpretation of these coefficients are available from the author upon request.

Notes: Standard errors are in parentheses. The method of estimation is ordinary least squares. The dependent variable is the natural logarithm of the contract price in the colonies denominated in Pennsylvania pounds.

Independent Variables

\[ \ln \left( \frac{1 - \exp(-rT)}{r} \right) \] discounted log of contract length measured in years where the discount rate is 25 percent.

Training provided: equals one if the contract stipulated employer provision of occupational training at a skilled trade and zero otherwise.

Employed at a skilled trade: equals one if the contract mentioned that the servant was to be employed at a skilled trade and zero otherwise.

Extra freedom dues: equals one if the contract stipulated the provision of dues at the end of the contract above the customary legal level and zero otherwise.

No freedom dues: equals one if the contract stipulated waiving the right to customary legal freedom dues and zero otherwise. The zero category for the two freedom dues variables is the provision of legal or "customary" freedom dues.

Servant as his own marketing agent: equals one if the servant was not directly "assigned" by an agent to a buyer and zero otherwise.

Sold by the ship's captain: equals one if the contract was "assigned" to a buyer directly by the captain of the ship on which the servant sailed and zero otherwise.

Female: equals one if the gender of the servant's first name was thought to be female and zero otherwise.

Married with a joint contract: equals one when a husband and wife were sold jointly under one contract with the same length and zero otherwise. The zero category for the gender and married variables is single adult male.

Year: the numerical year in which the servant arrived and was sold.

Order of sales: order in which the contracts were recorded as purchased, 1 to 498, in the 1745 market.

Fall: equals one if the contract was recorded as sold during the months of September through November and zero otherwise.

Winter: equals one if the contract was recorded as sold during the months of December through February and zero otherwise.

Spring: equals one if the contract was recorded as sold during the months of March through May and zero otherwise.

Summer: equals one if the contract was recorded as sold during the months of June through August and zero otherwise. The zero category for the seasonal variables is Summer for the 1745 sample and Winter through Spring for the 1771-1773 sample.

Port of Departure: equals one if the servant came from the port or region indicated and zero otherwise. Ulster ports are Londonderry, Belfast, and Newry. The South Ireland ports are Cork and Waterford. The zero category for all ports is from Dublin or just having the designation "Ireland" in the record (10 observations) or where the port of origin was not recorded (61 obervations).

Sources: See Table 1.
variables, their construction, and the regression results are given in Table 3.

At the time of contract formation in Europe recruiters would have information on the first fifteen and possibly the first nineteen variables listed in Table 3. The first seven were negotiated contract parameters: the discounted contract length, the provision of training or employment at a skilled trade, adjustments to the dues paid at the end of the contract, and who would be selling the servant. The second eight were observed servant characteristics and circumstances: gender, marital status, and time of arrival. The last four were the ports of departure.

The age, physique, and perceived health of the servants, important to determining their expected colonial value and observed by recruiters in Europe, were not recorded by the civil authorities. These variables, however, were embodied in the contract parameters, principally the length. It was through adjusting the contract length that recruiters arbitraged the value of this information. Therefore, the contract length serves as a proxy for age, physique, and any other observable servant characteristics not directly controlled in Table 3.19

The market was relatively efficient in arbitraging profitable information known at the time of servant recruitment in Europe. The amount of contract price variance explained by all the variables in Table 3 was small, 13 percent for the 1745 sample and 28 percent for the 1771 to 1773 sample. And the variables representing information known at the time

19 The rate assumed to discount all contracts was 25 percent; the results proved to be relatively invariant to rates ranging from 5 to 50 percent. The proper discount rate was not obvious. Other studies have simply assumed a rate without much justification. For example, the Galenson studies, see fn. 6, implicitly assumed a zero discount rate, and Heavner, "Indentured Servitude," pp. 73–75, assumed a 15 percent discount rate. A crude measure of the discount rate of new immigrant servant contracts was derived by comparing the average price to the contract-length ratio between resident and new immigrant servants. The measure assumed that the average price to length ratio should be constant across similar servants; any differences would therefore generate a residual discount rate:

\[
\frac{CPR}{TR} = \frac{CPI}{TI}/(1 + r)^{TI-TR}
\]

Where:

- \(CPR\) = average resident servant prices
- \(CPI\) = average immigrant servant prices
- \(TR\) = average resident contract lengths
- \(TI\) = average immigrant contract lengths
- \(r\) = discount rate

Applying the formula to the evidence cited in Table 1 yielded a discount rate of 25 percent, independent of the group of resident servants: resold immigrant contracts, local residents who voluntarily entered service, or local residents forced into service by debt. The values of immigrant contracts were discounted relative to resident servant contracts for several reasons: immigrants experienced higher morbidity and mortality, took longer to adapt to the new tasks required of them in the New World, and may have been more likely to run away because most of the contract’s compensation was already paid in the form of passage to the colonies. If the 25 percent was a risk premium, then the appropriate rate would be 25 percent plus the market rate. But because the 25 percent may also capture some real productivity differences between labor in the first year and subsequent years of the contract, the 25 percent rate was used as a best guess.
of recruitment, the major contract parameters, servant characteristics, and market conditions listed in the first fifteen variables in Table 3, explained only about 2 percent of the variance in contract prices. As a group, these fifteen variables were jointly insignificant. In addition, the rather large and unexplained residual variance in contract prices was relatively random over the chronological order of contract sales, as observed in the residual plots and measured by the Durbin-Watson statistic. Thus most of the realized fluctuations in contract prices appears to be unrelated to conditions known at the time of contract formation because the price differences relating to these conditions were arbitraged away in the competitive recruitment process.

On the individual level, recruiters in the 1745 sample completely arbitraged away the value of information pertaining to servant training, extra freedom dues, who would be the sales agent, the order of sale within the seasonal market, and the other information embodied in the contract length, such as age, physique, and health. Recruiters in the 1771 to 1773 sample completely arbitraged away the value of information pertaining to extra freedom dues, who would be the sales agent, and the seasonal and yearly pattern of prices.

The nature of the arbitrage process was apparent in several cases. For example, recruiters expected contracts associated with occupational training to have a relatively lower colonial value. Therefore, they negotiated these contracts to be 21.3 percent longer on average. The extra service time just offset the trainees’ lower value, and their contracts sold for the same price as other contracts. Therefore, merchants were fully compensated and were indifferent to shipping these less-productive servants.

Another example involved the order of sale in the 1745 sample. Controlling for the season of arrival, the order of sale indicates trends within the main fall and spring markets. Merchants were keenly aware of the competitive effects of arrival timing, as illustrated by a letter sent from Philadelphia to Ireland in 1766:

20 For the 1745 sample the partial F-statistic was 1.09 which indicated that the joint insignificance of these variables cannot be rejected with confidence, a .3 significance level. For the 1771 to 1773 sample the partial F-statistic was 1.78 which also indicated that their insignificance cannot be rejected with confidence, a .18 significance level. However, for the 1771–1773 sample this does not include the ports of departure which if included would raise the partial F-statistic to a significant level.

21 This adjustment may have been caused by the lower age and productivity of the trainees relative to the average servant. The effect was also consistent with the argument that their training was marketable (nonfirm specific) and so the cost should have been borne by the servant. The servant repaid the master’s training expenses by serving for a longer than normal period. See Gary S. Becker, Human Capital (2nd ed., Chicago, 1980), pp. 19–26, for a discussion of nonfirm specific human capital. Although the 1771–1773 sample does not have any contracts stipulating training, several indentured contracts renegotiated after arrival indicated that servants traded an extra year of service for including a new training provision in their contract.

22 All the immigrant servants arriving in 1745 were included in the sample in Table 3. This variable was not used in the 1771–1773 sample because this market had many other redemptioner
Irish servants will be very dull sale such numbers have already arrived from different ports & many more expected, that I believe it will be overdone, especially as several Dutch vessels are expected here, which will always command the market. Captain Power I believe has near sold all his, he being pretty early.23

Merchants arriving late in the seasonal market carried servants with contracts 4 percent longer on average than those delivered earlier in the season. The adjustment was apparently enough to maintain a constant price over each seasonal market.

Recruiters expected servants arriving in the main fall market to be less valuable than servants arriving in the spring market. Spring arrivals were offered shorter contracts than fall arrivals. In the 1745 sample spring contracts were 3.3 percent shorter; for 1771 to 1773 they were 8.3 percent shorter. Fall was the only season when German servants arrived in great numbers. Relatively longer contracts offered British servants arriving in the fall may have been compensation for merchants having to sell in a more competitive seasonal market.24 However, this adjustment was not enough to arbitrage seasonal price differences completely in the 1745 sample in which spring arrivals sold for prices 8 percent higher than fall arrivals. But by the 1771 to 1773 sample the increased lengthening of fall contracts relative to spring contracts had completely arbitrated away the seasonal price difference.

In several cases recruiters experienced difficulty in forecasting the value of available information and failed to fully arbitrage profit opportunities. The most important involves the price difference between males and females. Ex post, recruiters lost by shipping a female instead of a male. The average female price was 14.4 and 11.8 percent below the average male price in the 1745 and 1771 to 1773 samples.25 The approximate loss in shipping 66 females in the 1745 market and 248 females in the 1771 to 1773 market, in terms of lost opportunities to ship males, was 145 and 445 Pennsylvania pounds.26 Recruiters actually allowed females to have shorter contracts than males, by a quarter of a year on average, in the 1745 sample. Recruiters mistakenly expected

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24 The pattern of seasonal contract lengths was opposite of Galenson’s finding in White Servitude, p. 105, and was caused by the different nature of the Philadelphia market. The Philadelphia market was unique among the colonies in that almost half of the immigrant servants were Germans who arrived exclusively in the fall.

25 A lower contract price would also result if females were cheaper to transport or experienced lower voyage mortality. Existing evidence suggests this was not the case. See fn. 17; and Grubb, "Mortality and Morbidity."

26 The comparison assumes that recruiters could make substitutions on the margin without affecting the cost of recruiting. To fill the last few spots on the ship before sailing, recruiters may have accepted low-valued servants or offered shorter contracts thus lowering the profits on these last servants.
female contract lengths was the same as found by Galenson, *White Servitude*, p. 104, for English servants leaving London between 1718 and 1759. Either the relative value of male versus female servants was changing by 1745, at least in the Philadelphia market, or recruiters had overestimated the relative value of females for some time.


29 For example, prices for married servants were 10 percent lower, and prices for those with trade skills were 22 percent higher, than the 1771-1773 average. By waiving the right to freedom dues, a lower price of over 50 percent resulted in the 1745 sample. However, these cases only accounted for 14 contracts out of 1,338 and so are of minor importance. The difficulty in forecasting the value of some of these infrequently-used contract stipulations may explain why servants who wanted these conditions tended to opt for the redemptioner contract form. See Grubb, "Redemptioner Servants."

30 The Bristol coefficient was significantly different from the London coefficient in Table 3 with an F-statistic of 3.74 and significant at the .05 level. The Ulster and South Ireland coefficients were not significantly different.
groups were below those for Dublin servants, thus recruiters in Ulster may have slightly overestimated the value of their servants while recruiters in South Ireland may have slightly underestimated the value of their servants, relative to Dublin servants.31

CONCLUSIONS

Merchants transporting indentured servants from Europe to America were speculating in forward-labor contracts. They guaranteed the contract terms to the servant before sailing and then sold the contract in the colonies at auction. Merchants had to forecast the colonial price of each contract to successfully compete for servants in Europe. Separating predictable from unpredictable sources of price variance indicates that recruiters used information known at the time of recruitment with relative efficiency. They successfully arbitrated known profit opportunities relating to expected differences in colonial servant values. The minor areas of forecast error were between males and females, on a few infrequently-used contract stipulations, and across different ports of emigration. Recruiters slightly overestimated the relative value of female, Ulster, Bristol, and married servants. And they slightly underestimated the relative value of skilled and South Irish servants. The large variance in colonial auction prices was predominantly related to unforeseeable events that occurred after the voyage had begun. Thus the variance in contract parameters, principally contract length, was the best measure of permanent differences in servant human capital. And the variance in contract prices was the best measure of unexpected changes in servant values induced by events such as a traumatic voyage. The degree to which the trans-Atlantic labor market conformed to the efficient-market hypothesis, given the substantial level of risk and uncertainty, is suggestive of the general performance of American colonial markets.

31 The contract price and length adjustments across ports measured the relative market evaluation of servant human capital between groups. For example, because London servants had the same contract length as Dublin servants but sold for higher prices, the human capital of London servants must have been more highly valued in the colonial market than were Dublin servants. Similarly, because servants from Ulster and South Ireland sold for the same price but Ulster servants had shorter contracts, the human capital of Ulster servants must have been more highly valued in the colonial market than were South Irish servants.