

**ACCESSING RESOURCES IN A GLOBAL ECONOMY:
THREE ESSAYS ON OUTSOURCING AND IMMIGRATION**

by

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Abstract

This thesis is a collection of three manuscripts. In the first manuscript I develop a general equilibrium model that explains the growth and maturation of outsourcing – an outsourcing lifecycle – based on industry learning and market feedback. When outsourcing starts, buyers lack the knowledge to develop effective contracts so they rely on relationships. As contract knowledge develops, contracts become stronger and eventually replace relationships as the primary form of governance and the market grows. Under contractual governance, continued strengthening of contracts benefits buyers. The size of the market determines whether suppliers benefit or suffer with increased contracts strength.

The second manuscript explores the design of an optimal skills-based immigrant selection system based. This system is based on two factors: a threshold in predicted-earnings that is used to determine whom to accept and reject, and a human-capital-based earnings regression for making error-minimizing predictions of immigrant success in the host labor market. We first show how to design a points system based on what we assume to be the optimal predicted-earnings threshold and the optimal prediction regression. We next develop a method for identifying the optimal threshold given the prediction regression. The method produces a “selection frontier” that dictates the options facing policy makers. The frontier shows the tradeoff between the average quality of admitted immigrants and the number of immigrants admitted. The frontier shifts out with improved accuracy in predicting earnings as well as with increases in the variation and average quality of the applicant pool. Finally, we show how the policy maker chooses the optimal selection system given the selection frontier.

The third manuscript demonstrates the feasibility of the optimal immigrant selection method by developing an illustrative points system. We also explore how the selection system

can be improved by incorporating additional information such as country-of-origin characteristics and intended occupations. We discuss what our findings imply for the debate about the relative merits of points- and employment-based systems for selecting economic immigrants.

Co-Authorship

Chapters 3 and 4 were co-authored with John McHale

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Table of Contents

Abstract.....	ii
Co-Authorship	iv
Acknowledgements.....	v
Table of Contents.....	vi
List of Figures.....	viii
List of Tables	ix
Chapter 1.....	1
Chapter 2.....	3
2.1 Introduction.....	4
2.2 Literature Review.....	6
2.3 Model Development.....	11
2.3.1 Cost of Inputs.....	12
2.3.2 Choice of Governance.....	16
2.3.3 Supplier Profits – The Zero Profit Calculation	17
2.4 Equilibrium in the Outsourcing Market.....	18
2.4.1 Market Equilibrium – Endogenous Outsourcing Decision	19
2.4.2 Market Equilibrium – Endogenous Number of Buyers	24
2.4.3 Endogenous Outsourcing – Market Clearing Given Relational Governance	26
2.4.4 Endogenous Outsourcing – Market Clearing Given Contractual Governance	29
2.4.5 Endogenous Outsourcing – Consistency with Choice of Governance.....	30
2.4.6 Endogenous Outsourcing – Equilibrium Response to Contract Strength	32
2.5 The Outsourcing Lifecycle	34
2.5.1 The Outsourcing Lifecycle – A Numerical Example.....	34
2.5.2 The Outsourcing Lifecycle - Variations.....	38
2.6 Conclusion	40
2.6.1 Future Research	42
2.7 Appendix A – Establishing the External Option for Nash Bargaining	44
2.8 Appendix B – Proof of Propositions	46
2.9 References.....	50
Chapter 3 Optimal Design of an Immigration Points System.....	53
3.1 Introduction.....	54

3.2 Basic Points System Design.....	58
3.3 Derivation of the Selection Frontier.....	66
3.4 Choice of the Predicted-Earnings Threshold: An Illustrative Example.....	78
3.5 Concluding Comments.....	80
3.6 Appendix A – Details on Proofs	83
3.7 Appendix B – Omitted Steps Between Equations (10) and (11)	85
3.8 Appendix C – Proof of Existence of a Unique Interior Solution	87
3.9 References.....	90
Chapter 4.....	91
4.1 Introduction.....	92
4.2 Related Literature.....	95
4.3 Optimal Design Methodology.....	97
4.4 Data.....	100
4.5 Empirical Implementation	103
4.5.1 Base Regression.....	103
4.5.2 An Illustrative Points System.....	109
4.5.3 Extended Regressions	114
4.6 Concluding Comments.....	120
4.7 References.....	122

List of Figures

Chapter 2	
2.1 Buyer Sourcing Options and Associated Costs.....	12
2.2 Equilibrium Governance and Number of Suppliers.....	21
2.3 Cost as a Function of Contract Strength and Governacne Type	23
2.4 Possible Equilibria with Buyers and Suppliers	27
2.5 Equilibria with Contractual Governance.....	30
2.6 Governance and Market Response to Changing Contract Strength.....	33
2.7 The Outsourcing Lifecycle	37
Chapter 3	
3.1 Human Capital Levels for Acceptance and Rejection	61
3.2 Possible Selection Mistakes	62
3.3 Selection Frontier and Earnings Threshold.....	72
3.4 Expected Earnings by Proportion Admitted	77
3.5 Intersection of Selection Frontier with Indifference Curves.....	80
Chapter 4	
4.1 Estimated Cohort Year Effects	109

List of Tables

Chapter 4

4.1 Summary Statistics.....	103
4.2 Basic Log Earnings Regressions.....	106
4.3 Illustrative Points System	111
4.4 Extended OLS Regressions.....	115
4.5 Estimation of Occupation Effects	119

Chapter 1

Introduction

This dissertation is composed of three papers that are broadly linked by the theme of how to obtain specialized resources in an international economy. Whether those resources are in the form skilled human capital or embedded in production systems, this seems to be a problem that will continue to grow in importance for both firms and countries as the process of globalization continues. This thesis considers elements of the issue from firm and country perspectives.

The first paper addresses the issue from a firm perspective. In that paper, I develop a model of outsourcing that allows for contracts that, while typically incomplete, can get stronger over time as industries accumulate experience outsourcing a particular activity. In this model, firms can choose not only whether outsource or produce internally, but, if they outsource, whether to govern their suppliers by relational or contractual means. By allowing firms to choose how to govern their suppliers, it is possible that firms can avoid the opportunism normally associated with outsourcing by investing resources to develop relationships with suppliers. Alternatively firms can avoid making investments in relationships and instead rely on the strength of contracts.

The governance decision and market responses that emerge drive outsourcing through three phases which compose what I call the outsourcing lifecycle. The three phases are: Internal Provision, Relational Governance, and finally Contractual Governance. Each phase is characterized by different buyer decisions with respect to outsourcing and choice of governance along with different responses to increased experience in contracting.

While individual firms can access the benefits of foreign human capital through outsourcing, countries also benefit from having these skilled individuals as part of their local economies. To this end, competition amongst developed countries to attract skilled immigrants has been increasing. The next two papers address the issue of how a country can establish an optimal immigrant selection system. The first of these focuses on the development of an optimal immigration points system and a ‘selection frontier’ – the associated constraint for policy makers. Based on a policy maker’s relative valuation of human capital and numbers of immigrants, the points system allocates points to characteristics of human capital on the basis of a human capital-based earnings regression. The points are normalized such that individuals with 100 or more points are admitted and the rest are rejected. The selection frontier is shown to shift outwards with improved accuracy in predicting earnings as well as with increases in the mean and variance of the earnings in the pool of prospective immigrants.

The final paper provides an empirical implementation of the points system using Canadian data drawn from the Canadian Immigrant Database. In addition to demonstrating the feasibility of this approach, the paper provides evidence into how well these systems could perform and provides some direct comparison with the points offered under the current Canadian immigration system.

Chapter 2

Outsourcing Evolution:

The Development of an Outsourcing Lifecycle Model

Abstract

The emergence of low cost communication technology has enabled the offshoring of activities as disparate as call centers and financial analysis. Although many of these activities emerged at similar times and depend on similar technology, their markets are often quite different. In particular, some offshored services experience significant growth through the use of standardized processes and contracts; others remain small and rely on relational governance.

This paper develops a general equilibrium model that explains the growth and maturation of outsourcing based on industry learning and market feedback. When outsourcing starts, buyers lack the knowledge to develop effective contracts so they rely on relationships. As contract knowledge develops, contracts replace relationships as the primary form of governance and the market grows, benefiting both the buyers and suppliers.

Using this model, it is possible to predict to what degree and how quickly a market will grow and thus to develop more effective sourcing strategies.

2.1 Introduction

The emergence of low cost communication technology has enabled the offshoring of activities as disparate as call centers and financial analysis. Although these activities emerged at similar times and depend on similar technology, their respective markets now bear little resemblance to each other. India, for example, has a highly competitive marketplace for call centers, but relatively few financial analysis firms. Moreover, the buyer-supplier relationships are different: call centers are typically managed by standard contracts, while relationship managers seem to play a larger role in financial analysis. Comparing the two industries, the call center market appears to have matured in a way that the financial analysis industry has not – and perhaps never will.

These two industries are at different phases in a pattern of development that I call the outsourcing lifecycle. This lifecycle encompasses predictable changes in both the scale and approach to governance of outsourcing. Call centers now have reasonably well established industry best practices and key performance indicators. Together, these support standardized contracts with service level agreements, penalty clauses, and other techniques to ensure compliance. In other words, the contracts are quite strong and reasonably complete.

On the other hand, financial analysis services are harder to define and the quality of the finished product may not be easily verifiable. As a result contracts in this area will tend to be weaker and enforcement less complete. A service buyer who relies on these weak contracts would potentially be exposed to significant opportunism on the part of the supplier. To avoid these opportunism costs, buyers tend to rely on relational governance.

This paper develops a general equilibrium model that explains the growth in outsourcing of specific activities in terms of industry-wide learning about contracting and market-driven

feedback mechanisms. In what follows, I argue that when an activity is first outsourced, little is known about how to write effective contracts so buying firms use relational governance to control their suppliers. This protects buyers from supplier opportunism that would normally come as a result of weak contracts, but it also limits the size of the market. As experience with outsourcing grows, buyers develop stronger contracts. When contracts become strong enough, buyers switch to contractual governance which immediately improves the profitability of outsourcing and expands the market.

After buyers adopt contractual governance, the evolution of the industry follows the path determined by two sets of conflicting tendencies. Stronger contracts tend to lower outsourcing costs, which attracts more buyers and increases demand; the higher demand increases supplier profits tending to attracting more suppliers, which tends to lower buyer costs further. On the other hand, stronger contracts tend to directly lower supplier profit, lower profits drive suppliers out of the market; this increases buyer cost tending to drive buyers from the market as well resulting in still lower supplier profit. In this model, I show that, if the market achieves a critical supplier density, the buyer market will grow and the supplier market will shrink with increased contract strength; without sufficient density, the number of buyers and suppliers will fall as contracts strengthen.

Where this cycle ends depends on the fixed costs of supplier entry, the cost of building relationships, the potential demand for the activity and, in some cases, potential strength of contracts. This model can help firms predict the development of outsourcing industries and shed light on strategic issues: how quickly will outsourcing costs fall; will investing in relationships be valuable in the long run; should a candidate country's low labour costs compensate for weak legal systems when selecting an outsourcing location?

The remainder of the paper is organized as follows. I begin with a brief review of the relevant outsourcing literature, followed by an introduction to the basic model. Next, I examine the equilibrium characteristics and show how they change as a function of the strength of contracts. Using this model, I generate the outsourcing lifecycle. The balance of the paper describes the implications and insights this model suggests.

2.2 Literature Review

The history of outsourcing suggests that the decision to outsource is both time- and context-dependent. Some activities, such as strategic management, are rarely outsourced even though technology could conceivably support external provision. Other activities such as telephone-based product support, which were once exclusively in-house, are now outsourced as a matter of common practice. Falling service costs due to technological change is clearly a factor in the growth of outsourcing. That said, it is probably not the only factor since outsourcing appears to be expanding in spite of rising labour costs (Spencer 2005, Trefler 2005, Amiti & Wei 2004.)

A number of theories of outsourcing have been proposed to shed light on a firm's outsourcing decisions. Of these, transaction cost economics (TCE) has emerged as a dominant framework for considering the decision of whether or not to outsource.¹ TCE has been so widely

¹ Other frameworks include theories of strategic management, institutional theory, knowledge-based perspectives, and theories of power and politics. Each of these ideas enriches our understanding of the outsourcing decision and its consequences. See Dibbern et.al 2004 for a comprehensive review of theories. Unfortunately, the mechanism behind each of these theories is sufficiently different that they cannot reasonably be captured by one model. This paper will focus on the TCE view since it is well established in economics.

adopted that it appears to have taken the role of null hypothesis against which other theories are evaluated (Williamson 1985, Poppo & Zenger 2002, Bahli et.al 2003, Sampson 2004.)

When applied to outsourcing, TCE emphasizes the role of bounded rationality, opportunism, and asset specificity in the outsourcing environment. These give rise to the possibility of additional costs in market-mediated transactions, which would be negligible if the activities were conducted within the firm. These include the costs of finding potential suppliers; writing, monitoring and enforcing contracts; and hold-up cost (i.e. ex-post contract renegotiation) and other forms of opportunism. Countering these transaction costs are the benefits derived from external provision such as economies of scale and access to specific assets or knowledge. In TCE, the decision to outsource is based on the total cost of provision including transaction costs (Williamson 1985).

The TCE view highlights the fact that contracts are never complete. Firms may learn how to write better contracts but ultimately the effectiveness of contracts is constrained by the limits of bounded rationality, the uncertain nature of the activity being outsourced and / or the effectiveness of the legal environment in which the outsourcing takes place. As a result, moving activities outside the firm imposes a certain set of costs due to opportunism from incomplete contracts. In general, this means that one or both of the parties (in this case, the supplier) can extract some measure of additional profits by renegotiating the contract ex-post. The amount of ex-post renegotiation depends on ambiguity and uncertainty in the activity being outsourced as well as the quality of legal institutions, information, and skill in designing the contract. This potential for renegotiation becomes part of the transaction cost associated with external supply (Williamson 1985).

Building on the insights of TCE, Grossman and Hart (1986) and Hart and Moore (1990) examine issues relating to the optimal allocation of property rights. According to this view,

ownership represents residual control in the absence of an enforceable contract. A firm's decision to outsource transfers the residual rights to the supplying firm. This increases the incentives to make relationship-specific investments on the part of the supplier, resulting in a better product, but may also expose the buyer to additional hold-up costs.

These early models take the market environment as exogenous. McLaren (2000), Grossman and Helpman (2002, 2003, 2005), Antras (2003) and Antras and Helpman (2004) develop general equilibrium models that provide insights into the decision of whether and where to outsource when the market structure is endogenously determined. These papers highlight issues related to search costs, firm specific investment, supplier market density, and strength of contracts. While these general equilibrium models provide rich insights into the outsourcing decision and its impact on the industry, they focus on an environment where firms have the choice of outsourcing under incomplete contracts or integrating vertically. They do not explicitly allow for the possibility that buyer firms can avoid supplier opportunism while taking advantage of the potentially lower cost available on the outsourcing market; rather, they focus on the issue of outsourcing under weak contracts and opportunism vs. internal production.

The ideas developed in this paper depart from the standard view of outsourcing vs. vertical integration in response to incomplete contracts and instead focus on how to govern within an incomplete contract situation. In this respect, my research is more along the lines of Dixit (2003a, 2003b) and Greif (1993) who examine how international trade can be extended through relational-based enforcement for small groups or legal enforcement in larger groups. This paper develops a feedback mechanism whereby the choice of governance is not only shaped by the market environment but that it shapes the market environment by affecting the profitability of outsourcing.

There is a significant amount of research addressing the problem of how the buyer firm can govern suppliers in an environment of incomplete contracts. For the purposes of this paper, the approaches of interest can be grouped into contractual governance and relational governance. Contractual governance is the form of governance typically associated with TCE. Under this framework, parties sign a contract that, in conjunction with a legal and informational environment, is assumed to constrain their actions and determine their outcomes. Within these contractual constraints, the parties act to maximize their individual profits. There is a vast literature on issues relating to contractual governance. Topics covered include issues of contract design, the allocation of authority, measurement of outputs vs. processes and contingent payments, as well as other factors affecting the optimal design of contracts (Ouchi & Maguire 1975, Aghion & Tirole 1997, McLaren 1999, Baker et.al. 2002 and Levin 2003).

Under relational governance, contracts are viewed as the codification of an agreement rather than a mechanism to control behaviour. The parties abide by the agreement reflected in the contract in spite of the inability to legally enforce it. Contracts remain incomplete, but when a circumstance arises that is not covered by the contract, the parties resolve the issue cooperatively with a view to fairness for the other party (as in theories of reciprocity, trust and embeddedness) or with an eye to protecting the possibility of future gainful trade (as in more traditional economic approaches).

Relational governance has a long intellectual history going back to early work on the functioning of contracts by Macaulay (1963), who documented the fact that contracts were often viewed as secondary to relationships in the enforcement of agreements. Later research has suggested that relational governance can be effective through shared norms and values (Uzzi 1996, Ostrom 2003, Granovetter 2005), through reputations (e.g. Dixit 1993, Greif 2006) or

through the promise of future interaction as in the Folk Theorem resolution of the Prisoner's Dilemma.

Recent work on relational governance involves formalizing the notion of self-enforcing relational contracts built on subjective, non-verifiable performance measures (Baker et.al 2002, Levin 2003). The inclusion of these performance measures allow for improvements relative to contracts over objective measures. In this framework, the participants to the contract are encouraged to abide by un-enforceable agreements in a manner similar to the folk theorem resolution of The Prisoner's Dilemma. Defaulting on an agreement risks the prospect of gains from future interaction and therefore the parties abide by agreements.

Relational governance has been considered as either a substitute for or complement to contractual governance (Poppo & Zenger 2002) and in terms of which collections of controls work best under different outsourcing situations (Kirsch 1997). As with the foundational research on allocation of authority and property rights as a method of governance, these works take the market environment as exogenous. My research builds in an endogenous component to show how governance structure and market characteristics can co-evolve. Although these forms of governance can work together, for analytic clarity, I will treat them as mutually exclusive.

While relational governance brings the benefits of cooperation, it also entails costs and other limitations not present in purely contractual governance. The nature of these costs depends on the process that generates or sustains relationships. If relationships are based on a pattern of trust or reciprocity developed over a shared history, they could take time and money to build. Alternatively if relationships are based on an expectation of future interactions, relational

governance might limit the number of potential suppliers based on the amount of future business that could be promised.²

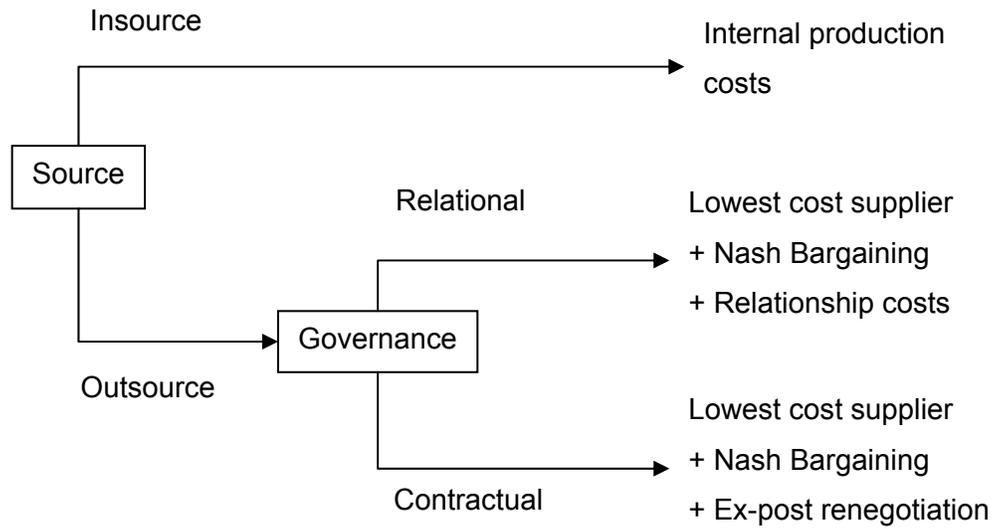
In the next section, I develop a model that brings together relational and contractual governance. Through the balance of the paper, I will use this model to develop the outsourcing lifecycle.

2.3 Model Development

The economy is composed of M buyers who are identical aside from internal production costs. Each buyer requires a distinct intermediate product (either good or service) as part of their production process which can be produced internally or outsourced. If a given buyer outsources, “he” can use relational governance, which involves an up-front relationship-building cost, or contractual governance, which may expose him to supplier opportunism. Outsourcing is taken as being an irreversible activity based on incomplete information. Buyers and suppliers have access to the same production technology. Each buyer knows his own costs and the probability distribution of suppliers’ costs when deciding to outsource, but he does not know the supplier’s actual cost until after committing to outsource at which time the cost becomes known and verifiable. As a result, the outsourcing and governance decisions are made on expected outsourcing costs. The buyer’s sourcing options and their cost elements are presented in Figure 1.1.

² In the model that follows, I assume that relationships have a fixed cost to develop. While this assumption more naturally reflects theories of embeddedness and shared norms, it also has an economic interpretation as an investment in monitoring technology. Basing relationships on limiting the number of suppliers might provide a more direct fit with theories of relational incentive contracts; however, the models should behave the way aside from the transitional phase when relationships breakdown.

Figure 1.1: Buyers Sourcing Options and Associated Costs



To make his sourcing decision, the buyer must first determine the expected cost of outsourcing under relational and contractual governance. He compares the lesser of these with his own production costs to determine whether or not to outsource.

In the balance of this section, I develop the basic elements of the model: buyer costs, supplier profits and the governance decision. In the subsequent section, I use these elements to determine the outsourcing equilibrium. To simplify the process, I initially hold the number of buyers fixed at B where $B \leq M$ and focus on how the governance decision and supplier market change in response to contract strength. I then endogenize B and trace out the outsourcing lifecycle.

2.3.1 Cost of Inputs

The supplier market is composed of N firms who are identical aside from their actual cost of producing a specific input. If the buyer outsources, he will select the supplier who can produce

his specific intermediate product at the lowest cost and negotiate with “her” over the surplus generated relative to the next-best supplier using Nash Bargaining. In the case of relational governance this will result in a unit price that is the production cost plus 50% of the surplus. Since this model requires two suppliers as the basis for negotiation, I assume that $N \geq 2$ when there is positive outsourcing. The resulting expected price will be:

$$(1) \quad E[P^R] = E \left[S^* + \left(\frac{S^{**} - S^*}{2} \right) \right],$$

where S^* and S^{**} are the lowest and second lowest marginal production costs.

One of the key ideas in this paper and indeed the wider outsourcing literature is that incomplete contracts are characterized by opportunism. To legally enforce a contract requires the aggrieved party to demonstrate that the counter-party failed to deliver per the contract. The inability for third parties to verify aspects of outsourced activity (e.g. quality, production processes) or for the buyers to completely specify requirements ex-anti (e.g. product characteristics, delivery timing, quantities required) and therefore omit important details from the contract will tend to favor supplier. Rather than being able to find legal fault with his supplier, the buyer is likely to receive ‘exactly what he asked for but not what he wanted’ and thereby be exposed to supplier opportunism to correct the contract’s shortcomings.

This is not to say that contractual weakness always favors the supplier – there are clearly interpretations of weakness that can favor (or harm) either party. Contractual weakness might leave room for opportunism on either side if the contract was enforceable but contained elements whose implications were not completely understood by the participants (cost escalation clauses or lack thereof) or if contract elements are enforceable but established ex-post (e.g. meeting unspecified quality levels). Finally, room for opportunism could exist for either party if the

outsourced activity involved joint production since failure to deliver might be caused by one party but legally attributed to the other.

As a simplifying assumption, I focus on supplier opportunism, recognizing that there is a case for buyer opportunism as well. In this case, under contractual governance, the supplier will behave opportunistically. The impact of opportunism is captured by a single contractual “incompleteness” term $\lambda \in [0,1]$ where the supplier will obtain a λ share of the remaining surplus.³ Since λ represents the contract incompleteness, it combines a variety of factors such as contract writing expertise, strength of legal systems, ability to monitor or verify supplier activities and ability to specify tasks.

A key assumption of this paper is that, as experience with outsourcing grows, λ tends to fall. Since some tasks are harder to contract than others (inherent task ambiguity, difficulty verifying quality etc.) and enforcement of contracts is more difficult in some areas than others (cultural factors, strength of legal systems, systems for monitoring) so in some cases, λ could be restricted to a smaller range $\lambda \in [\underline{\lambda}, \bar{\lambda}]$ where $0 \leq \underline{\lambda}, \bar{\lambda} \leq 1$. This allows for the possibility that some activities start out with stronger contracts and that some activities might always entail some amount of opportunism no matter how much buyers learn about writing contracts.

³ The weakness term has two mathematically consistent interpretations. The first is that weakness in the contract is a measure of “slack” that allows the supplier to push the price towards that of the external option. This can be motivated by thinking of the contract as a collection of tasks that could have been assigned to either the first or second-best suppliers. Given the incomplete contract, some of these tasks are enforceable, others are not. Under this interpretation, λ measures the share of tasks that are not enforceable. These tasks are subject to ex-post renegotiation whereby the supplier can push the price for these tasks to the limit of the cost that would be charged by the second-best supplier.

The second interpretation is that λ is the probability that a situation arises that invalidates the contract, leaving the supplier room to renegotiate. In this case, the supplier will push the price for the whole contract back to the second-best supplier’s cost. As a result, the price shown below in (2) is the expected price given uncertain contract enforcement, but otherwise the result is the same.

To allow for buyer opportunism, λ could range over $[-1, 1]$. Negative values would capture the possibility that the buyer could take advantage of the supplier to the degree that contracts are weak. Since this paper focuses on the situation where weakness in the contracting environment favours the supplier, this possibility will be ignored for now.

The resulting unit price is the amount under relational governance plus this additional opportunism cost:

$$(2) \quad E[P^C] = E\left[S^* + \left(\frac{1}{2}\right)(S^{**} - S^*) + \left(\frac{\lambda}{2}\right)(S^{**} - S^*)\right].$$

To calculate these expected values requires picking a specific distribution for S.

Consistent with Grossman and Helpman (2005), I assume that S_i will follow a uniform density;

that is, $S_i \sim U(0, 1)$ for all suppliers and buyers. It is well-known that the k^{th} order statistic from

the distribution $U(0,1)$ has an expected value of $\frac{k}{N+1}$. The expected values of S^* and S^{**} are

thus:

$$(3) \quad E[S^*] = \frac{1}{N+1},$$

and

$$(4) \quad E[S^{**}] = \frac{2}{N+1}.$$

Substituting these into the expected price given relational governance yields:

$$(5) \quad E[P^R] = E\left[\frac{S^* + S^{**}}{2}\right] = \frac{3}{2(N+1)}.$$

Which is the lowest cost supplier's expected marginal cost plus 50% of the expected surplus.

Repeating these steps with the contractually governed price yields:

$$(6) \quad E[P^c] = \frac{1}{N+1} + \frac{1+\lambda}{2} \left(\frac{2}{N+1} - \frac{1}{N+1} \right) = \frac{3+\lambda}{2(N+1)},$$

Which is the lowest cost supplier's expected marginal cost plus the supplier's share of the surplus plus the cost of supplier opportunism. This expected cost contributes to the decision of whether or not to outsource and to the choice of governance mechanism.

2.3.2 Choice of Governance

As mentioned above I assume that relationships require fixed investments to develop and maintain. The buyer chooses his governance strategy to minimize the expected cost of outsourcing including this relationship cost. Since prior to determining cost information buyer firms are identical, the buyer's choice of governance amounts to choosing a number of firms with which to build relationships. This strategy can be captured by a single variable, k , which captures the share of the supplier market with which the buyer builds relationships. Letting R represent the cost of a relationship and Q the quantity purchased, an individual buyer's expected cost is⁴:

$$(7) \quad E[C^B] = kQE[P^R] + (1-k)QE[P^c] + kRN.$$

Substituting in the values calculated above, the total expected cost as a function of k is:

$$(8) \quad E[C^B] = \frac{(3+\lambda)Q}{2(N+1)} + \left(RN - \frac{\lambda Q}{2(N+1)} \right) k.$$

⁴ Treating k as continuous is justified if N is large or if one thinks of the investment of R as a measure of the probability that a relationship will be established.

Since this is a linear function of $k \in [0,1]$, buyers will develop relationships with all or none of the suppliers based on the rule:

$$(9) \quad k = \begin{cases} 0 & \text{if } RN - \frac{Q\lambda}{2(N+1)} \geq 0 \\ 1 & \text{if } RN - \frac{Q\lambda}{2(N+1)} < 0. \end{cases}$$

With a fixed number of firms engaged in outsourcing there are no other buyer decisions.

The next step is to establish the supplier side of the market.

2.3.3 Supplier Profits – The Zero Profit Calculation

To determine the number of suppliers in equilibrium, supplier profits – which depend on the choice of governance – must be set to zero. If a supplier is selected by one buyer, her expected profit will be:

$$(10) \quad E[\pi^R] = \frac{1}{2} \left(\frac{1}{N+1} \right),$$

under relational governance, and

$$(11) \quad E[\pi^C] = \frac{1+\lambda}{2} \left(\frac{1}{N+1} \right),$$

under contractual governance.

If B buyers each outsource Q units of production to a market composed of N suppliers, the expected profit for each supplier is:

$$(12) \quad E[\pi^s] = \frac{1}{N} \left(kQB E[\pi^R] + (1-k)QB E[\pi^C] \right) - F.$$

In this equation, the leading $1/N$ indicates the probability that this supplier is selected, k reflects the share of outsourcing covered by relationships and F represents the supplier's fixed cost of entering the market. Substituting in equations (10) and (11) yields:

$$(13) \quad E[\pi^s] = kQB \frac{1}{2N} \left(\frac{1}{N+1} \right) + (1-k)QB \frac{1+\lambda}{2N} \left(\frac{1}{N+1} \right) - F.$$

Under the market-clearing assumption of zero profits this becomes:

$$(14) \quad NE[\pi^s] = BQ \left(\frac{1+(1-k)\lambda}{2(N+1)} \right) - NF = 0.$$

This completes the basic model. The remainder of the paper uses this model to develop the outsourcing lifecycle.

2.4 Equilibrium in the Outsourcing Market

In this section, I develop the equilibrium response as a function of contract strength. I start with the relatively simple case where the buyer's outsourcing decision is taken to be exogenous. This results in a fixed number of buyers, B , and an endogenously determined number of suppliers N . I then turn to the more realistic case where the potential buyers choose to outsource or not in order to minimize expected costs. In the latter case, the number of buyers and the number of suppliers are determined simultaneously as a function of contract strength.

2.4.1 Market Equilibrium – Endogenous Outsourcing Decision

If the number of buyers is exogenously set at B , equilibrium is characterized by these buyers being satisfied with their choice of governance and suppliers earning zero expected profits. The buyer's governance decision is captured by equation (9) and the number of suppliers is found by solving equation (14) to obtain N as a function of k and λ :

$$(15) \quad N(k, \lambda) = -\frac{1}{2} + \frac{1}{2} \left(1 + \frac{2BQ(1 + (1-k)\lambda)}{F} \right)^{1/2}.$$

To find a relationally-governed equilibrium, I assume the buyers choose relational governance (i.e. $k = 1$) and determine the market-clearing N . If this N is one that supports the buyer's choice of relational governance, the combination is an equilibrium. Substituting $k = 1$ into equation (15) the number of relationally governed suppliers is:

$$(16) \quad N^R(k = 1, \lambda) = -\frac{1}{2} + \frac{1}{2} \left(1 + \frac{2BQ}{F} \right)^{1/2}.$$

It is worth noting that, in a relationally governed equilibrium, N is not a function of λ , so the number of suppliers does not change with changes in the strength of contracts as long as relational governance is maintained. This makes sense since the relationship, not the contract, protects the buyer from opportunism.

The final step is to confirm that buyers would choose relational governance given N^R suppliers. Substituting (16) into the $k = 1$ branch of (9) and solving the resulting equation for λ yields the condition that satisfies the relational governance and market clearing, namely:

$$(17) \quad \lambda > \frac{BR}{F}.$$

When this condition holds, there will be a relationally governed equilibrium.

To find the contractually-governed equilibrium, I repeat the process with the $k = 0$ branch of (9). The market clearing number of suppliers is:

$$(18) \quad N^C(k=0, \lambda) = -\frac{1}{2} + \frac{1}{2} \left(1 + \frac{2BQ(1+\lambda)}{F} \right)^{1/2}.$$

Substituting (18) into the $k = 1$ branch of (9) simplifies to:

$$(19) \quad BR(1+\lambda) \geq \lambda F.$$

Rearranging (19) gives the two conditions on λ that satisfy contractual governance:

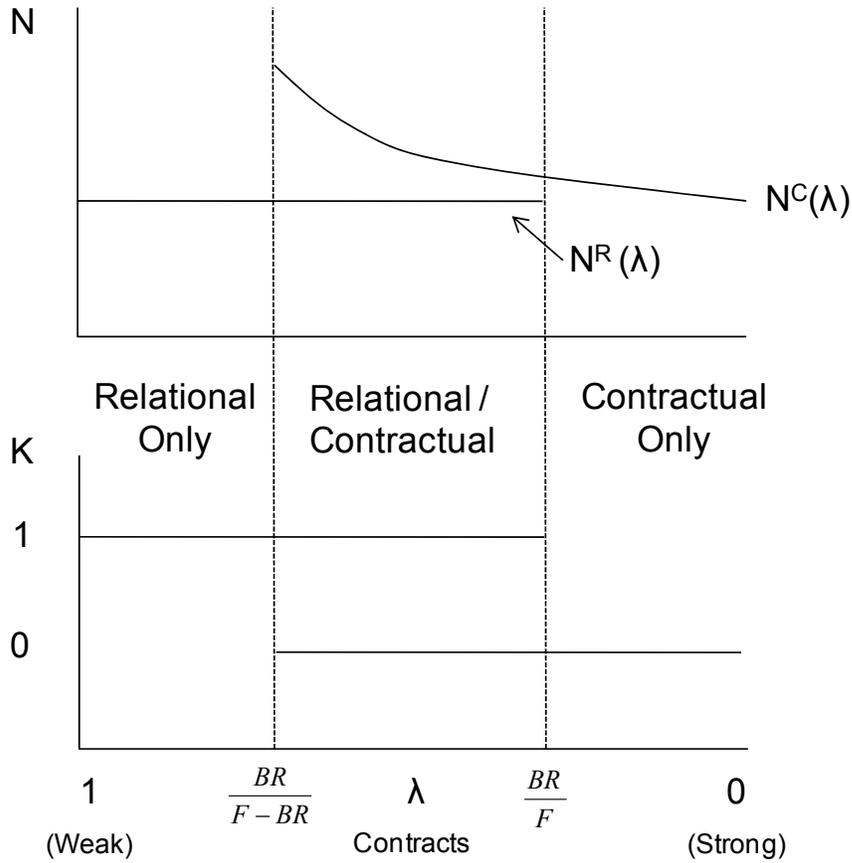
$$(20) \quad \begin{cases} \lambda \geq 0 & \text{if } BR > F \\ \lambda < \frac{BR}{F - BR} & \text{if } BR < F. \end{cases}$$

If $BR > F$ contractual governance would be possible for any level of contract strength.

When this occurs, $BR/F > 1$ so relational governance could not be supported for any λ . The second condition requires that contracts be sufficiently strong before there can be an equilibrium with contractual governance. If either condition in (20) holds, there is an equilibrium with $k = 0$ and N given by equation (18).

Since the second condition is more interesting, I will focus on that version for the remainder of the paper, recognizing that the characteristics of the contractual governance equilibrium, when it exists, would be the same in either case. The resulting equilibria are shown in Figure 1.2 below.

Figure 1.2: Equilibrium Governance and Number of Suppliers



As shown above, for sufficiently weak contracting environments, there can only be equilibria with relational governance. With strong contracting environments, there can only be equilibria with contractual governance. Between these extremes, there is a range where equilibria with a relatively small, relationally governed market or a larger, contractually governed one are both possible. Since $BR/(F - BR) > BR/F$ there must be an equilibrium with either relational, contractual or both forms of governance for every value of λ .

As shown in Figure 1.2, the number of suppliers is larger under contractual governance than it is under relational governance for any $\lambda > 0$. To confirm this, note that N^C from equation

(18) is larger than N^R from equation (16) for any λ . It follows this that suppliers have an incentive to improve the contract-writing expertise to encourage the shift to contractual governance. Once contractual governance is achieved, suppliers no longer have an interest in improving the strength of contracts.

Since the number of buyers is assumed to be fixed, it does not make sense to consider how changing contract strength affects the number of buyers. One can however consider how the strength of contracts impacts the buyers' costs. To do this, I substitute the market clearing number of suppliers under the two governance mechanism into the cost equation (8) and rearrange. Under relational governance, $k = 1$ the expected cost is:

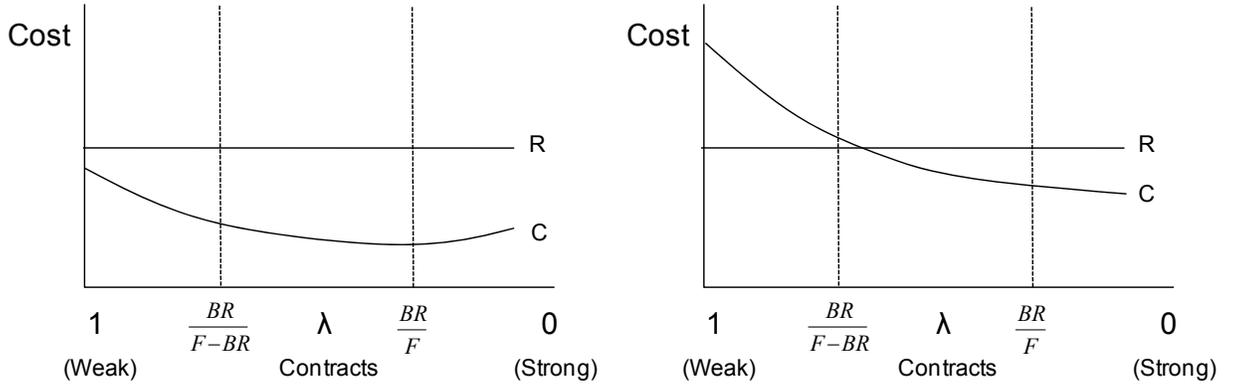
$$(21) \quad E[C^B(\lambda, k = 1)] = \frac{Q(3 + RB/F)}{1 + \left(1 + \frac{2BQ}{F}\right)^{1/2}},$$

which is a constant. If the buyer uses contractual governance, $k = 0$ and the expected cost is:

$$(22) \quad E[C^B(\lambda, k = 0)] = \frac{Q(3 + \lambda)}{1 + \left(1 + \frac{2BQ(1 + \lambda)}{F}\right)^{1/2}}.$$

This function is not monotonic in contract strength, the ambiguous response results from two opposing forces on the buyer's cost. The first is a direct effect: stronger contracts reduce opportunism and therefore reduce the expected cost for any given number of suppliers. The second is an indirect effect: strengthening contracts reduces supplier profits and shrinks the supplier base. With fewer suppliers, the expected cost of the lowest-cost suppliers increases, tending to increase the buyer's cost. This increases expected costs and, at a minimum, offsets some of the cost reduction. At the extreme, the indirect increase could more than offset the direct impact leading to higher costs. To illustrate these effects, the buyer's average unit cost as a function of λ for two different fixed costs are shown in Figure 1.3.

Figure 1.3 Cost as a Function of Contract Strength and Governance Type



The left panel depicts a situation where, if sustainable, contractual governance would yield a lower cost than relational governance for any λ . This would tend to occur if fixed costs were small relative to potential outsourcing revenue, which causes opportunism to attract a greater number of suppliers, or the cost of developing relationships were high.

Even though it would result in a lower cost, contractual governance is not possible over the range $1 \geq \lambda > BR/(F - BR)$. The seeming contradiction is that each buyer would prefer to use relational governance given the number of suppliers that would result from a contractually-governed equilibrium. But when each buyer selects relational governance, the contractually governed equilibrium cannot be sustained.

Both panels of Figure 1.3 show the cost of contractual governance is below the cost of relational governance in the range of $\lambda < BR/F$. This result can be confirmed by substituting $\lambda = BR/F$ into the contractually-governed cost curve (22) and comparing it to the relationally governed cost curve. The numerators are the same, but the denominator in (22) is higher, so the cost must be strictly lower. It is also the case that when $\lambda = 0$ the cost of contractual governance

must be lower than the cost of relational governance since the denominators for the two cost curves are the same but the numerator is lower in the contractually governed cost curve.

While suppliers benefit from increased profits at the point of transition to contractual governance, buyers benefit from falling cost. Thus buyers could also benefit from sharing their contract-writing expertise below this point. Once contractual governance is achieved, buyers are no longer incented to share contract-writing expertise since the number of suppliers falls with λ and a shrinking supplier base increases buyer's expected costs.

If the number of buyers could increase in response to improved contract enforcement, buyers might be incented to share contract knowledge beyond the level necessary to support contractual governance, since the increased number of buyers might attract additional suppliers. To study this feedback loop requires a model with an endogenous outsourcing decision. That model is developed in the next sub section.

2.4.2 Market Equilibrium – Endogenous Number of Buyers

Until now, the number of buyers has been fixed. This is not realistic in most situations since a cost-minimizing buyer will outsource when the expected cost from outsourcing is less than his own production costs⁵. In this section I extend the analysis to the situation with an endogenous outsourcing decision leaving only contract strength exogenous. Equilibrium now requires that suppliers earn zero profits, those who outsource make the correct governance decisions, and buyers choose to outsource when the expected cost of external supply is lower than their own production costs.

⁵ It may be a reasonable approximation if all firms who are able to outsource are doing so or if the outsourcing decision is driven by reasons other than cost minimization.

In what follows, I begin by examining the market-clearing conditions as a function of λ assuming that either relational governance or contractual governance holds. This analysis will show that there is at most one relationally-governed equilibrium and/or one contractually-governed equilibrium for each λ – similar to what was obtained above. I then address the consistency of the equilibrium with the choice of governance. To do this, I show how the equilibrium B and N change in response to λ and establish thresholds where relational and contractual governance can be consistent with the calculated equilibria. The results will be similar to the case where B was exogenous – weak contracts will tend to favour relational governance, strong contracts contractual governance, and there will be a range of λ where both types of governance are possible.

Endogenizing the outsourcing decision requires one additional equation: the number of buyers who outsource. Recall that buyer's production cost are drawn from the same $U(0,1)$ distribution as the suppliers; thus the share of buyers who outsource is given by the area under the distribution that is less than the expected cost as given by equation (8). The number of buyers is:

$$(23) \quad \begin{cases} B = M \left[1 - \frac{3}{2(N+1)} - \frac{RN}{Q} \right] \geq 0 & \text{if } k = 1 \\ B = M \left[1 - \frac{3 + \lambda}{2(N+1)} \right] & \text{if } k = 0. \end{cases}$$

Since the number of firms depends on the choice of relational or contractual governance, each of these cases will be developed separately, starting with relational governance.

2.4.3 Endogenous Outsourcing – Market Clearing Given Relational Governance

Any relationally-governed equilibrium must satisfy the supplier's zero profit condition from equation (16):

$$(16) \quad N^R = -\frac{1}{2} + \frac{1}{2} \left(1 + \frac{2BQ}{F} \right)^{1/2},$$

and the number of buyers captured by the $k = 1$ branch of equation (23):

$$(24) \quad B^R = M \left[1 - \frac{3}{2(N+1)} - \frac{RN}{Q} \right] \geq 0.$$

The first thing to note is that $N = 0, B = 0$ solves the system, which means that there is always the possibility of an equilibrium with no outsourcing. The second thing is that neither equation is a function of λ , so changes in λ that do not cause the buyer to shift from relational to contractual governance will not change the equilibrium number of buyers or suppliers. The other equilibria are found by ignoring the bound on B and substituting (24) into (23):

$$(25) \quad N^R = -\frac{1}{2} + \frac{1}{2} \left(1 + \frac{2MQ}{F} \left[1 - \frac{3}{2(N+1)} - \frac{RN}{Q} \right] \right)^{1/2}.$$

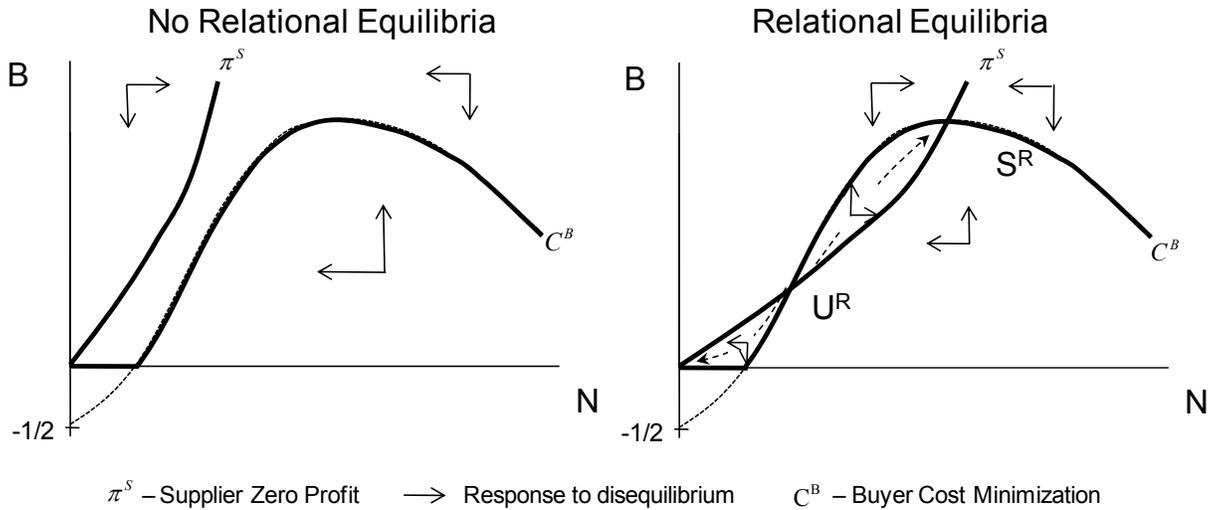
The solutions for N are the roots of the polynomial:

$$(26) \quad N^3 + \left(2 + \frac{RM}{2F} \right) N^2 + \left(1 + \frac{RM}{2F} - \frac{MQ}{2F} \right) N + \frac{MQ}{4F} = 0.$$

Based on this equation, I establish: Lemma 1: There will be at most two outsourcing equilibria under relational governance (for proof, see Appendix B.) Lemma 1 suggests that the level of outsourcing under relational governance would be indeterminate. Fortunately, as I show below, if there are two distinct positive equilibria, only one of them is stable; if there is only one,

as would be the case if there were repeated roots, there is no stable outsourcing solution. The stability of the candidate solutions can be seen by examining the disequilibrium response as indicated by the arrows on Figure 1.4.

Figure 1.4 – Possible Equilibria with Buyers and Suppliers



To understand the disequilibrium response, consider first what happens when the system is not on the supplier zero profit line. Since additional buyers increases supplier profits, the number of suppliers increase on points above the supplier’s zero-profit curve, π^S , and decrease on points below. Since the C^B curve represents the number of buyers who will choose to outsource for a given number of suppliers, buyers will exit on points above the C^B curve and enter on points below as indicated by the arrows. Together, these characterize the stability of any candidate equilibrium.

In the first panel of Figure 1.4, relationally-governed outsourcing is not possible since the curves do not intersect in the positive quadrant. This is equivalent to not having any positive root to equation (26). The only equilibrium would be at the origin – with no relationally-governed

outsourcing. This would be stable since any supplier who entered would experience negative profits and exit. A stable outcome with no outsourcing would tend to occur with fixed costs that are high relative to the potential revenue in the market, high relationship costs and low quantities.⁶ Though relational governance is impossible, outsourcing might still be possible under contractual governance.

The second panel of Figure 1.4 shows the possibility for three equilibria – the ‘no outsourcing equilibrium’ as well as equilibria at U^R and S^R . The equilibrium U^R is not stable, since if any suppliers exit, the buyer’s expected cost increases resulting in buyer exit, which in turn reduces supplier profit and drives out suppliers. This process continues until there are no suppliers and no buyers. If any suppliers enter from point U^R , buyers’ expected cost falls, attracting more buyers which induces still more suppliers until the point equilibrium at S^R is reached.⁷ The point S^R is stable, however, since movement away in any direction is pushed back to this point.

If the two roots are positive but not distinct, then the π^S and C^B curves would touch at only one point: U^R and S^R would coincide. This equilibrium, which is not depicted on Figure 1.4, would not be stable. If suppliers exited from such an equilibrium, the market would collapse as it did from point U^R . If additional suppliers entered, there would be negative supplier profits and they would exit as they did with C^R . As a result, this equilibrium resists positive shocks but not negative ones, so the market will eventually collapse.

⁶ Increasing F or reducing Q rotates the π^S curve up; reducing Q shifts the C^B curve down reducing the space for overlap.

⁷ Similar reasoning can be applied to the number of buyers.

2.4.4 Endogenous Outsourcing – Market Clearing Given Contractual Governance

The results for contractual governance follow a similar pattern. The equilibrium occurs where there are zero expected supplier profits as given in equation (18):

$$(18) \quad N^C = -\frac{1}{2} + \frac{1}{2} \left(1 + \frac{2BQ(1+\lambda)}{F} \right)^{1/2},$$

and the number of buyers captured by the $k = 0$ branch of equation (23):

$$(27) \quad B^C = M \left[1 - \frac{3+\lambda}{2(N+1)} \right] \geq 0.$$

As with relational governance, this generates a no-outsourcing solution. Unlike the situation with relational governance, when outsourcing occurs, the level depends on λ . The system can be solved by substituting (27) into (18):

$$(28) \quad N = -\frac{1}{2} + \frac{1}{2} \left(1 + \frac{2QM}{F} \left[1 - \frac{3+\lambda}{2(N+1)} \right] (1+\lambda) \right)^{1/2}.$$

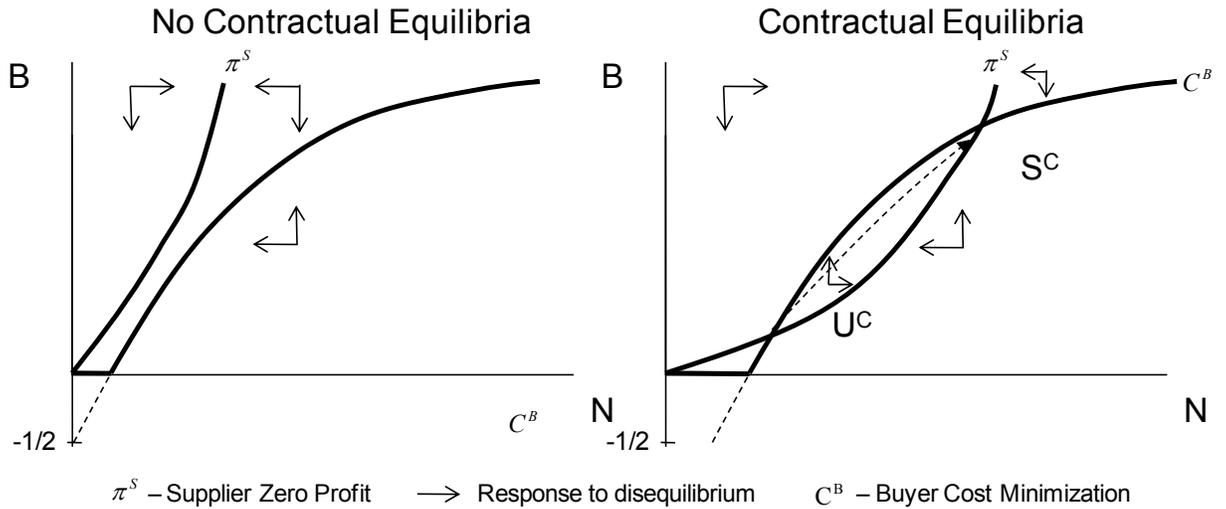
Solving for N yields the 3rd order polynomial:

$$(29) \quad N^3 + 2N^2 + \left(1 - \frac{QM(\lambda+1)}{2F} \right) N + \frac{QM(\lambda^2 + 2\lambda + 1)}{4F} = 0.$$

Based on this equation, I establish Lemma 2: There will be at most two outsourcing equilibria under contractual governance (for proof, see Appendix B.) Lemma 1 and Lemma 2 together prove Proposition 1: There will be at most two positive outsourcing equilibria.

As with relational governance, Lemma 2 suggests that there are one or two positive equilibria for any given λ . Applying the analysis developed above to the equilibria as depicted in Figure 1.5, shows that at most one of them can be stable.

Figure 1.5 – Equilibrium with Contractual Governance



The key result is there is at most one stable outsourcing equilibrium for each of relational and contractual governance. For relational governance, the equilibrium number of suppliers and buyers does not depend on λ ; for contractual governance, the number of suppliers and buyers both depend on λ .

2.4.5 Endogenous Outsourcing – Consistency with Choice of Governance

In the previous subsection I showed that there is at most one stable equilibrium for each type of governance. As it stands, these points are only candidate equilibria since I still need to establish when those equilibria are consistent with the buyer's choice of governance. I will first address the consistency of relational governance which follows directly from the case where the number of buyers was exogenously determined. I will then address the situation for contractual governance which is more subtle and relies on the relative cost of relational and contractual governance in the neighborhood around $\lambda = B^R R / F$.

For S^R to be a relationally-governed equilibrium, the associated N^R and B^R must yield the governance decision $k = 1$ in equation (9). In the case where B was exogenous, this condition was given by $\lambda > BR/F$. Since this applies to any B , it applies when $B = B^R$. So any candidate relationally-governed equilibrium where $\lambda > B^R R/F$ is a relationally governed equilibrium.

For an outcome to be a contractually-governed equilibrium it must yield $k = 0$ in equation (9). The approach used to establish the bounds for relational governance will not work for contractual governance since B^C is a function of λ . When the number of buyers was fixed, I showed above that for an arbitrary B when $\lambda < BR/F$ the cost of contractual governance is below the cost of relational governance. Again, since this applied for an arbitrary B , it applies when $B = B^R$ so the cost associated with the contractually-governed equilibrium is strictly lower than the cost of relationally governed equilibrium for all $\lambda \leq B^R R/F$. Since lower costs imply a greater number of outsourcers, $B^R > B^C$ for all $\lambda \leq B^R R/F$. Moreover, since this cost is strictly lower when $\lambda = B^R R/F$, there is a range where contractual governance yields lower costs even when $\lambda > B^R R/F$. This will turn out to generate an upper bound on where contractual governance can be supported so I will denote the boundary λ as λ^C .

Based on equations (16) and (18), a larger number of buyers, along with the additional profits associated with opportunism, implies a larger number of suppliers so $N^C > N^R$ for $\lambda \leq B^R R/F$. Strictly more supplies together with reduced opportunism ensures that equation (9) will yield contractual governance for any contract strength $\lambda \leq \lambda^C$ where $\lambda^C > B^R R/F$. It follows that if a candidate contractually-governed equilibrium exists when $\lambda < \lambda^C$ it is consistent with the governance choice.

2.4.6 Endogenous Outsourcing – Equilibrium Response to Contract Strength

To conclude this section, I will identify how these equilibria change as a function of contract strength – which will allow us to determine the outsourcing lifecycle. Since relationally-governed equilibria do not change with λ , the question centers on the contractually-governed equilibria.

Proposition 2: When $N \geq 2$,

$$(30) \quad \frac{dN}{d\lambda} = \frac{QM(N - \lambda - 1)}{F(6N^2 + 8N + 2) - QM(\lambda + 1)} > 0.$$

Proposition 3a:

$$(31) \quad \frac{dB}{d\lambda} = \frac{-M}{2(N+1)} + \frac{(3 + \lambda)QM^2(N - \lambda - 1)}{2(N+1)^2 F(6N^2 + 8N + 2) - QM(\lambda + 1)}.$$

Proposition 3b: For $N > N^*(\lambda)$, $dB/d\lambda < 0$ where $dN/d\lambda < 0$.

Proofs: See appendix B.

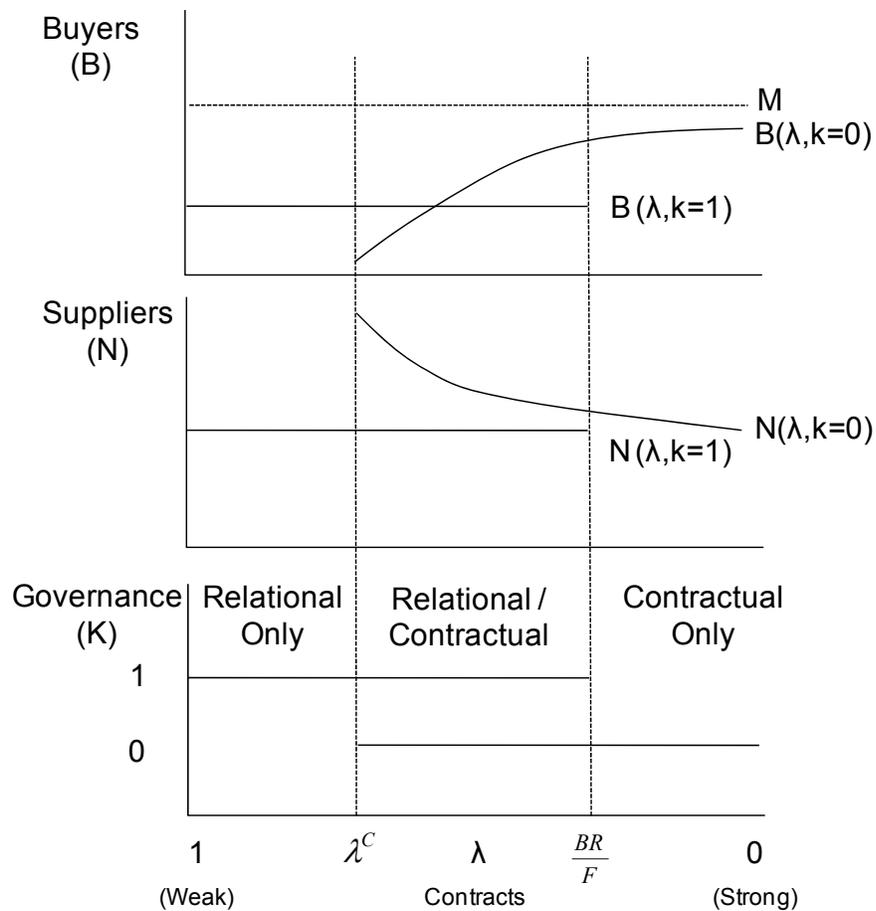
Based on proposition 2 the number of contractually-governed suppliers decreases as contracts get stronger. The number of buyers takes a more interesting path; according to proposition 3b the number of buyers will increase if the supplier market is sufficiently large, but could decrease if the market is too small. Since the latter possibility amounts to buyers doing worse as a result of stronger contracts, the situation bears more consideration.

As I mentioned above, the expansion or contraction of the market depends on the direct and indirect effect of contract strength on buyer costs and supplier profits. The direct effect of increased contract strength is an improvement in costs due to lower opportunism; the indirect effect, which is always in the opposite direction, is an increase in costs due to a reduction in supplier choice. When the market is large, adding or subtracting one supplier has an insignificant

impact on expected cost; when the market is small, the impact can be very significant. If the markets are sufficiently small, the indirect effect can swamp the direct effect and buyers experience a net increase in costs.

Based on the above analysis, the relationship between outsourcing and contract strength is very similar to the situation depicted in Figure 1.2 with an additional panel for changes in the number of buyers. In particular, when contracts are very weak, only relational governance is possible; when contracts are very strong, only contractual governance can be supported; for intermediate ranges both may be possible. These results are shown in Figure 1.6.

Figure 1.6 – Governance and Market Response to Changing Contract Strength



The analysis so far demonstrates that there is typically a range where there are two consistent sets of equilibria, one for each of contractual and relational governance. The final step is to resolve the potential for multiple equilibria that arises in the intermediate range where both contractual and relational governance are possible. To do this, I will assume that there are costs associated with switching governance methods such that, once buyers select a method of governance, they will stick to it as long as it can be sustained given the strength of contracts. With this assumption in place, the outsourcing lifecycle converges to a single path as a function of the strength of contracts

2.5 The Outsourcing Lifecycle

In this section, I will use the model to trace out the phases in the outsourcing lifecycle using a numerical example. I will then explain why the outsourcing might get stuck at different locations in the lifecycle. Finally, I will use the model to consider the difference in development between markets for call centers and financial analysis services.

2.5.1 The Outsourcing Lifecycle – A Numerical Example

For this example, I will assume that the product being outsourced has a potential demand of 600 units composed of a moderate number of potential buyers, $M = 20$, each of whom has a small demand ($Q = 30$). Relationships will be relatively inexpensive to maintain with an $R = 1$, but there is currently no outsourcing.

According to the model, there can be two reasons for not outsourcing. It is possible that the cost of external provision is too high to justify outsourcing. Since marginal costs are assumed to be drawn from the same distributions for both the buyers and suppliers, the high cost of outsourcing is captured by a high fixed cost for suppliers. If costs are too high, outsourcing could be initiated by an exogenous technological change which lowers cost.

The second reason for no outsourcing was identified in section 4 – that the cost is sufficiently low to support outsourcing but that the market is in a stable no outsourcing equilibrium. If this is the case, outsourcing could be initiated by a supply or demand shock that could move the market above the point U^R or U^C as in Figures 1.4 or 1.5. Above this point, the market will continue to sustain itself and will move to an equilibrium.

For this example, I will assume that the cost is initially too high to support outsourcing with $F = 30$. Since there is no history of outsourcing, there is no experience in writing contracts and they should be very weak. I will let the initial $\lambda = 1$ and assume that the lower bound, $\underline{\lambda} = 0$. With these parameters, ($Q=30, M=20, R = 1, F= 30, \lambda = 1$) there is no positive solution to either equations (27) or (33) so there can be no outsourcing. This characterizes the first phase of the outsourcing lifecycle: Internal Provision. As the name suggests, this phase is characterized by no outsourcing, there are no suppliers and no active buyers.

The internal production phase ends when F falls sufficiently low to initiate outsourcing. In this example, I will assume a new technology emerges that reduces F to 15. After costs fall, the parameters are ($Q=30, M=20, R = 1, F= 15, \lambda = 1$). Given these values, the minimum market size necessary to support outsourcing, as given by the point U^R has less than one buyer and one

supplier. Thus a single buyer supports more than the U^R number of suppliers and so he could initiate outsourcing through his demand alone⁸.

When the outsourcing process starts, the market will be very small. By the time the number of suppliers is 2, the buyers will choose relational governance ($k=1$) in accordance with equation (9) to minimize costs. According to the assumption that switching equilibria has costs, as the market grows to the stable relationally-governed equilibrium, S^R , choice of governance will be maintained as long as it remains a viable equilibrium. When S^R is reached, $B \approx 10.1$ and $N \approx 2.7$. This size of market supports relational governance according to equation (18) since $\lambda > BR/F = 10.1/15 \approx 0.67$, so the outcome is an equilibrium. Outsourcing has entered the second phase of the lifecycle: Relational Governance. Since buyers are now outsourcing, they will gradually accumulate knowledge about how to develop better contracts. Nevertheless, the market remains at S^R so long as $\lambda \geq 0.67$.

Throughout the Relational Governance phase, both buyers and suppliers have an incentive to share contract-writing expertise with the rest of the market. With the accumulation of outsourcing experience, contracts will eventually become strong enough that $\lambda < 0.67$. When this occurs, the market will enter the next stage of the outsourcing lifecycle: Contractual Governance.

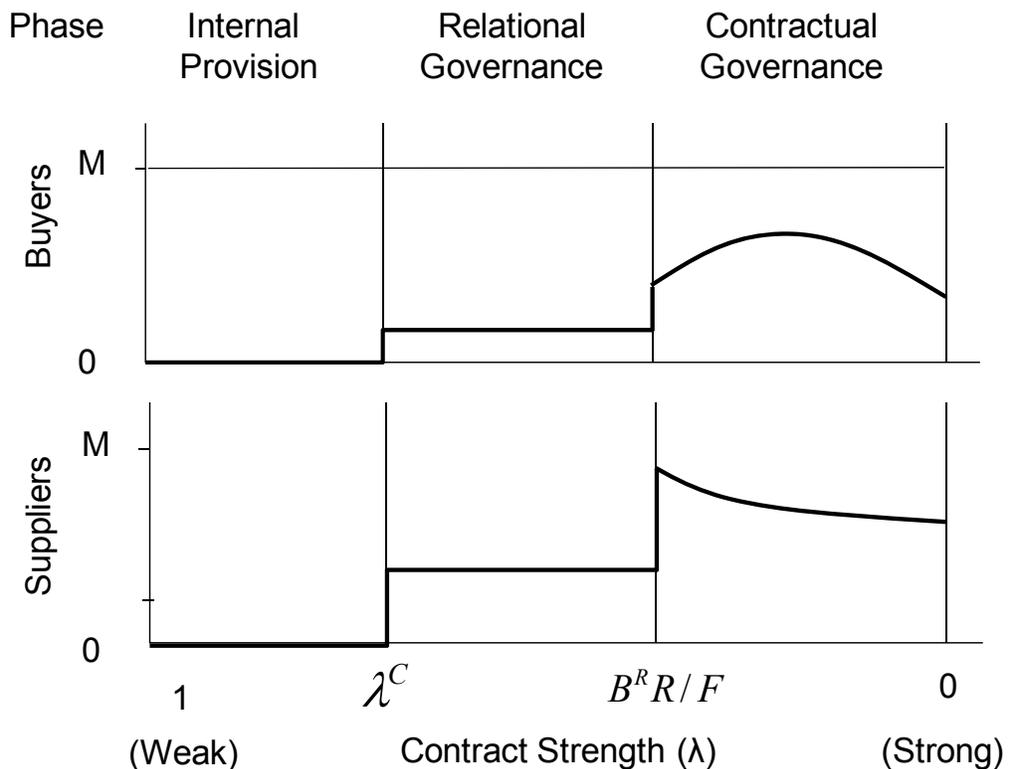
In the Contractual Governance phase, buyers are faced with $\lambda < 0.67$ and N^R suppliers. In response they will abandon their relationships in favour of contractual governance. Doing so increases supplier profits due to opportunism which attracts more suppliers. The increase in supplier base reduces the buyer's costs and increases the number of buyers as well. This initiates

⁸ In principle, a single supplier could also initiate the process by offering outsourcing services, the pricing mechanism in this model assumes that there are at least two suppliers, so a minor adjustment would need to be made to ensure consistency. It seems that this could be done by assuming a negotiating alternative of $S^{**} = 1$.

another cycle of supplier expansion and so on until the market reaches S^C ($\lambda = 0.67$) at this point, $B \approx 12.9$ and $N \approx 4.2$. The market is now at a contractually-governed equilibrium.

As further outsourcing experience accumulates, λ continues to fall and with it, the equilibrium number of suppliers and buyers change. According to propositions 2, the number of suppliers falls. The number of buyers will tend to rise if there is a large number of suppliers and fall for a small number. In this example, the number of buyers initially rises but ultimately falls as the supplier market shrinks. The final market becomes $B \approx 12.67$ and $N \approx 3.1$; the market is larger than it was when it was relationally governed but smaller than it was at the start of the contractually governed phase. These phases are depicted in Figure 1.7 below.

Figure 1.7 – The Outsourcing Lifecycle



2.5.2 The Outsourcing Lifecycle - Variations

The example developed above went through all the stages of the outsourcing lifecycle, though it need not have been the case. The outsourcing of a particular activity could essentially skip a phase or get ‘stuck’ somewhere.

I already mentioned that the lifecycle could become stuck at the Internal Provision phase. This result seems most likely when U^R has more than 1 buyer. If this occurs, even though outsourcing could be profitably sustained in equilibrium, no single buyer firm has sufficient demand to attract enough suppliers to make outsourcing worthwhile. Presumably, this outcome could be dislodged by a coordinated effort of high-cost suppliers approaching the market together⁹.

If the outsourcing does occur, the lifecycle could get stuck in the relationally governed phase if the learning process stopped at when $\underline{\lambda} > \lambda^C$. This situation could occur if legal systems did not effectively enforce contracts, if the buyers’ requirements were difficult to specify or if the quality of the final product could not be verified.

On the other hand, outsourcing could essentially skip a phase. For example, if the costs of relationships are high or fixed costs are low such that $B^R R / F > 1$, there will not be an appreciable Relational Governance phase. Instead, the nascent market may begin with weak contracts and a small number of firms at some point above U^R on Figure 1.4 moving towards S^R . Since $B^R R / F > 1$ implies S^R does not satisfy relational governance, before the market reaches S^R , relationships will be abandoned. Instead of stopping at the Relational Governance phase, the market will continue to expand under Contractual Governance until S^C is reached. Though

⁹ If the model allowed for variation in firm size, it might be the case that a single sufficiently large firm would emerge to initiate outsourcing.

relationships would still be used when the market emerges, the Relational Governance phase would not be an equilibrium.

The Outsourcing lifecycle provides a framework for predicting the development of outsourcing markets. Returning to the motivating example of call center vs. financial analysis, given the similarity in technology used (computers, telephone systems and databases), the model suggests that the difference in contract strengths could be driving the development of the two markets. Over time, the call center industry has developed industry best practices, key performance indicators and standard template contracts with service level agreements and penalty clauses – in other words, strong contracts. It is reasonable to think that call center outsourcing has moved through the Internal Provision and Relational Governance phases and is now in the contractual governance phase. Given the size of the market, it is likely that, if contracts continue to improve, buyers will continue to benefit, though suppliers should experience pressure on profits.

Financial analysis, on the other hand, seems to be more difficult to contract due to the idiosyncratic nature of the work and difficulty verifying the quality of output. As a result, it appears to be stuck in the Relational Governance phase. To move beyond this phase, there needs to be an increase in the strength of contracts or a growth in demand for service. An improvement in contracts could come about from increased standardization of the activities – which might encourage the growth in contracting knowledge. Growth in demand will increase the number of suppliers under the relationally governed equilibrium. This will increase the cost of maintaining relationships and reduce the cost of opportunism due to weak contracts – both of which tend to favour contractual governance.

2.6 Conclusion

Whenever a firm outsources an activity, it transfers a measure of control to the supplier. As a result of this transfer, the buying firm is exposed to the supplier's opportunistic behaviour. This model shows how, through managing their suppliers and developing stronger contracts, buyers can drive the process of outsourcing through a predictable lifecycle. The lifecycle starts with Internal Production – the activities are done in-house by all firms. When the cost of external provision is low enough, outsourcing begins with a small number of buying firms who use relationships to manage their suppliers. The market expands until equilibrium is achieved with Relational Governance. In this phase, the market is relatively static and small. With experience outsourcing, buyers learn how to write better contracts and eventually this lowers the cost associated with supplier opportunism. When it is low enough, buyers abandon relationships and enter the Contractual Governance phase. The market initially grows, lowering costs and increasing profits for suppliers. As learning continues, the number of suppliers (and, for small markets, the number of buyers) falls. For large markets, the number of buyers and the profitability of outsourcing continues to rise.

The model explains why different outsourcing activities perform differently. A process like financial services, where requirements are hard to define and quality is difficult to measure, should have small markets with relatively high-costs and relational governance; by contrast, a process like call centers whose requirements can be more clearly defined should experience significant growth and rely on contracts.

This model also demonstrates the importance of relational governance as a starting point for growing an outsourcing industry. The model suggests that even outsourcing activities that are destined to become contractually governed move through a phase of relational governance when

the activity first emerges. Since these relationships are required when contracts are weak, the outsourcing activities are likely to emerge where ‘relationship infrastructure’ is already in place through common culture and language, physical proximity and existing social networks. From there, it can move to locations where there are strong legal institutions once it has reached the Contractual Governance phase.

The Relational Governance phase is characterized by a relatively static market in spite of firms developing a better understanding of how to write contracts. That said, the transition from Relational to Contractual Governance phases is marked by a drop in outsourcing costs typically followed a further reduction as the market expands. This suggests two strategy elements for would-be buyer firms. The first is that, while the ability to develop effective relationships may be sufficient to minimize cost when outsourcing starts, for many activities¹⁰ the transition to contractual governance will lead to further cost reductions. Outsourcing these activities to areas with strong legal institutions will allow for further reductions in λ and will lead to lower costs as the market develops.

The second strategy element is that, faced with this possibility, buyers should value maintaining flexibility in negotiations with suppliers. Flexibility could be maintained by developing shorter term agreements, meet or release and market testing clauses for pricing.

Lastly, the model highlights that there is a point, in small markets, where further strengthening of contracts will harm both buyers and suppliers. This counterintuitive finding is a result of a conflict between the direct benefit and indirect harm from strengthening contracts. As contracts get stronger, buyers get a direct benefit in the form of better outcomes for any number

¹⁰ Specifically, those which do not have prior limits on λ . This would involve little ambiguity, easy to measure and verify outcomes, well developed key performance indicators etc. Large potential markets compound this benefit since learning should occur more quickly and buyer costs should continue to fall with λ over a longer range.

of suppliers. When contracts are stronger, however, buyers suffer an indirect cost from a shrinking number of suppliers. For small markets, the indirect impact of a shrinking supplier pool can more than offset the direct benefit from stronger contracts and buyers can suffer.

2.6.1 Future Research

The model provided in this paper advances our understanding of how the strength of incomplete contracts, governance choice, and market development work together to drive outsourcing through a standard lifecycle. While this paper provides a new way to look at these issues, it is only a first step. There is much work to be done both in terms of theory and empirical development. I will address each of these below.

While the model does provide some interesting insights, as is always the case there is a tradeoff between simplicity and tractability for complexity and realism. The current model favours simplicity, so generalizations of the framework should be explored, in particular, to determine the robustness of the results to different distributional assumptions. Given the complexity of solving systems of three non-linear equations, this would likely involve numeric analysis and simulation.

Unlike many of the general equilibrium models of outsourcing, this model does not allow for changing wage rate or varying characteristics between countries. An extension to the basic framework should be able to address this shortcoming and explicitly consider how outsourcing would evolve between countries in response to characteristics such as different legal systems and prevailing wage rates. This extension would enrich the predictions about outsourcing's development.

The current specification of relationships is based on the notion of investing in a shared history that involves an investment to develop. That these relationships disappear so quickly seems like a stark result at odds with the notion of valuing a shared history. A more realistic model would allow new firms to enter without relationships while existing firms allow their relationships to lapse over time. This model could be reflected by having one cost to build relationships and another, lower cost to maintain them. In turn, this might give rise to a mixed equilibrium with some relational and some contractual governance.

From an empirical perspective, the model should be confronted with data. Currently there does not appear to be a well-established dataset that is appropriate for testing the model econometrically, so a case study approach seems warranted.

2.7 Appendix A – Establishing the External Option for Nash Bargaining

This appendix shows that given two or more suppliers, the external option for Nash Bargaining with the lowest-cost supplier is the cost of the second-lowest supplier. To do so, I consider an alternate bidding game that would take place amongst all suppliers and the buyer. To be consistent with the model in the main text, I assume that there are N suppliers with production cost $S^1 < S^2 \dots < S^N$.¹¹ There is one buyer who would like to purchase Q units and whose opportunity cost is $S^B < S^N$ – this ensures that the buyer will purchase rather than exit the market.

I assume that if Nash Bargaining were to break down, the buyer would enter a competitive bidding process. The bidding process would have each supplier proposes a per-unit price P_t^i to supply up to Q units in period t . Together $P_t = (P_t^1, P_t^2 \dots P_t^N)$ with $P_t^{Min} = \text{Min}(P_t^1, P_t^2 \dots P_t^N)$. The buyer's choice is represented by $X_t = \{A, R\}$ to accept or reject the lowest bid. If the buyer accepts, the quantity is given to the lowest bid supplier (random breaking of ties where n denotes the number of ties for lowest bid). If the buyer rejects, the game repeats with $Q \rightarrow Q - 1$ units to reflect the cost the delay.

The expected payoff for supplier i is:

$$(A1) \quad \pi_t^i(Q, P_t, X_t) = \begin{cases} Q(P_t^{Min} - S^i) / n & \text{if } X_t = A, P_t = P_t^i \\ 0 & \text{if } X_t = A, P_t \neq P_t^i \text{ (or } Q = 0) \\ E[\pi_{t+1}^i(Q-1, P_{t+1}, X_{t+1})] & \text{if } X_t = R. \end{cases}$$

¹¹ Superscripts are used to identify suppliers $i=1..N$ (rather than stars) and the buyer B , subscripts are used for time.

The buyer's payoff is:

$$(A2) \quad \pi_t^B(Q, P_t, X_t) = \begin{cases} Q(S^B - P_t^{Min}) & \text{if } X_t = A \text{ (or } Q = 0) \\ E[B(Q-1, P_t, X_t)] & \text{if } X_t = R \end{cases}$$

This is a finite game with at most Q periods. A strategy in any period is a vector of bids for suppliers and a choice for the buyer to accept or reject the minimum bid. The Nash Equilibrium (NE) in each period t must satisfy $(P_t^1 \rightarrow S^2, P_t^2 \geq S^2, P_t^3 \geq S^3 \dots P_t^N \geq S^N)$ ¹² and for the buyer to accept. To see why, consider the position of suppliers $i \geq 3$. These suppliers cannot lower their bids below S^2 since winning with that bid is strictly dominated by losing with a higher bid. So they will not be selected, and are indifferent between bidding their cost and above. Supplier 2 cannot lower her bid and given that supplier 1 has undercut her by epsilon, she too will lose. Supplier 1 wins if the buyer accepts.

Based on the supplier 1's expectation of a win, she might be inclined to raise her bid, but $P_t^1 > S^2$ could not be part of a NE since that would induce supplier 2 to choose $P_t^2 = P_t^1 - \Delta > S^2$ and given supplier 2 profits above 0. The buyer would accept S^2 or lower since backwards induction will eventually cause the buyer to face $(S^B - S^2)$ or 0 in round Q where he will accept.

Since each period is the same, supplier 1 and supplier 2 will both offer within epsilon of S^2 in the first round. So the external option to Nash Bargaining is S^2 or S^{**} in the main text notation.

¹² The notation $A \rightarrow B$ indicates A must be within an arbitrarily small epsilon of B .

2.8 Appendix B – Proof of Propositions

Lemma 1 & 2: The proofs for these follow the same form. The equilibria for relational and contractual governance are given by the equations:

$$(B1) \quad N^3 + \left(2 + \frac{RM}{2F}\right)N^2 + \left(1 + \frac{RM}{2F} - \frac{MQ}{2F}\right)N + \frac{MQ}{4F} = 0,$$

and

$$(B2) \quad N^3 + 2N^2 + \left(1 - \frac{QM(\lambda + 1)}{2F}\right)N + \frac{QM(\lambda^2 + 2\lambda + 1)}{4F} = 0.$$

As 3rd degree polynomials, (A1) and (A2) each have three roots that follow one of two patterns: either all real or one real and two imaginary. Since M, Q, and F are positive, and $\lambda \geq 0$, the intercept is positive. Furthermore, the cubic term has coefficient +1. These properties ensure that there is at least one negative real root. Since one of the three roots is negative, there can be at most two positive solutions.

□

Proposition 2: When $N \geq 2$,

$$\frac{dN}{d\lambda} = \frac{QM(N - \lambda - 1)}{F(6N^2 + 8N + 2) - QM(\lambda + 1)} > 0.$$

Proof: Totally equation (33) yields:

$$(B3) \quad \left[3N^2 + 4N + \frac{2F - QM(\lambda + 1)}{2F}\right]dN + \left[\frac{-2QMN}{4F} + \frac{2QM(\lambda + 1)}{4F}\right]d\lambda = 0,$$

which can be rearrange it to obtain:

$$(B4) \quad \frac{dN}{d\lambda} = \frac{QM(N - \lambda - 1)}{F(6N^2 + 8N + 2) - QM(\lambda + 1)}.$$

The sign of (A4) depends on the denominator, which can be rearranged as:

$$(B5) \quad 6F(N^2 + N) + 2F(N + 2) - QM(\lambda + 1).$$

U under contractual governance, N is given by equation (18) as:

$$(B6) \quad N^C = -\frac{1}{2} + \frac{1}{2} \left(1 + \frac{2BQ(1 + \lambda)}{F} \right)^{1/2}.$$

Ignoring the C superscript:

$$(B7) \quad N^2 = \frac{BQ(1 + \lambda)}{2F} - N.$$

Substituted this into equation (A5) yields a more useful form of the denominator:

$$(B8) \quad (3B - M)Q(1 + \lambda) + 2F(N + 2).$$

B must satisfy equation (27), substituting in $N \geq 2$ into (29) confirms that (A5) is positive:

$$(B9) \quad B^C = M \left[1 - \frac{3 + \lambda}{2(N + 1)} \right] = M \left[1 - \frac{3 + \lambda}{2(2 + 1)} \right] \geq M \left[1 - \frac{2}{3} \right] = M/3.$$

Substituting B^C back into (A6) confirms that at its minimum value:

$$(B10) \quad (M - M)Q(1 + \lambda) + 2F(N + 2) > 0.$$

□

Proposition 3a:

$$\frac{dB}{d\lambda} = \frac{-M}{2(N + 1)} + \frac{(3 + \lambda)QM^2(N - \lambda - 1)}{2(N + 1)^2 F(6N^2 + 8N + 2) - QM(\lambda + 1)}.$$

Proof: To determine how the number of buyers responds, differentiate (27) to obtain:

$$(B11) \quad \frac{dB}{d\lambda} = \frac{-M}{2(N + 1)} + \frac{(3 + \lambda)M}{2(N + 1)^2} \frac{dN}{d\lambda}.$$

Then substitute in $dN/d\lambda$ from proposition 2 to obtain:

$$(B12) \quad \frac{dB}{d\lambda} = \frac{-M}{2(N+1)} + \frac{(3+\lambda)QM^2(N-\lambda-1)}{2(N+1)^2 F(6N^2+8N+2) - QM(\lambda+1)}.$$

□

Proposition 3b: For $N > N^*(\lambda)$, $dB/d\lambda < 0$ where $dN/d\lambda < 0$.

Starting with $dB/d\lambda$ from proposition 1 use the substitution in (A8) to obtain:

$$(B13) \quad \frac{dB}{d\lambda} = \frac{-M}{2(N+1)} + \frac{(3+\lambda)QM^2(N-\lambda-1)}{2(N+1)^2(3B-M)Q(1+\lambda) + 2F(N+2)}.$$

Then based on equation (27) substitute in:

$$(B14) \quad 3B - M = M \left[\frac{4(N+1) - 9 - 3\lambda}{2(2+1)} \right].$$

to obtain:

$$(B15) \quad \frac{dB}{d\lambda} = \frac{-M}{2(N+1)} + \frac{(3+\lambda)QM^2(N-\lambda-1)}{2(N+1)^2 \left(M \left[\frac{4(N+1) - 9 - 3\lambda}{2(2+1)} \right] \cdot Q(1+\lambda) + 2F(N+2) \right)}.$$

The denominator is positive so the sign is determined by the numerator:

$$(B16) \quad -(4N-5-3\lambda)(1+\lambda) - \frac{4F}{MQ}(N+1)(N+2) + 2(3+\lambda)(N-\lambda-1).$$

Since the N-squared term is negative, if N is sufficiently large, $dB/d\lambda$ must be negative. The

lower boundary where this occurs, $N^*(\lambda)$ is given by the solution to the quadratic:

$$(B17) \quad N^2 + \frac{MQ}{4F} \left(\frac{12F}{MQ} - 2 + 2\lambda \right) N + \frac{MQ}{4F} \left(\frac{8F}{MQ} + 1 - \lambda^2 \right) = 0.$$

This is:

(B18)

$$N^*(\lambda) = \left(-\frac{MQ}{4F} \left(\frac{12F}{MQ} - 2 + 2\lambda \right) \pm \left(\left(\frac{MQ}{4F} \left(\frac{12F}{MQ} - 2 + 2\lambda \right) \right)^2 - 4 \frac{MQ}{4F} \left(\frac{8F}{MQ} + 1 - \lambda^2 \right) \right)^{1/2} \right) / 2.$$

By inspection the positive root is increasing in λ , so the size of supplier market necessary to ensure that the number of buyers rises with λ increases with λ . \square

2.9 References

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Chapter 3

Optimal Design of an Immigration Points System

Abstract

There is growing interest in the United States and elsewhere in the use of a points-based system for selecting immigrants on the basis of their observed human capital. This paper explores the design of an optimal skills-based immigrant selection system based on two basic elements: a predicted-earnings threshold for determining whom to accept and reject, and a human-capital-based earnings regression for making error-minimizing predictions of immigrant success in the host labor market. We first show how to design a points system based on what are assumed to be the optimal predicted-earnings threshold and the optimal prediction regression. We next develop a method for identifying the optimal threshold given the prediction regression. The method produces a “selection frontier” that dictates the options facing policy makers. The frontier shows the tradeoff between the average quality of admitted immigrants and the number of immigrants admitted. The frontier shifts out with improved accuracy in predicting earnings as well as with increases in the variation and average quality of the applicant pool. Finally, we show how the policy maker chooses the optimal selection system given the selection frontier.

3.1 Introduction

In recent years, a number of industrialized countries have restructured their immigrant selection systems to better target more skilled workers. Australia has increased the share of permanent immigrants selected on the basis of skills, and has fine-tuned its points system to “select for success” based on measures such as mandatory English language testing and rigorous screening of qualifications (Hawthorne, 2005). Canada revamped its points system in 2002 in the face of deteriorating immigrant labor market performance, making it more focused on human capital based indicators of long-term success in the labor market. New Zealand has increasingly focused on attracting highly skilled workers through its points system, with emphasis on current New Zealand employment or firm job offers since 2004. Planning is well advanced in the United Kingdom to introduce a permanent points-based system to replace the pilot system that has been in place since 2002 (U.K. Home Office, 2006).

Elsewhere, skills-based immigration reform is being actively considered, even if the actual reforms have so far been tentative. After extensive debate, Germany adopted a more skill-focused system at the beginning of 2005, but plans to introduce a fully-fledged points system went down in a narrow legislative defeat. The governments of France and Ireland have announced they are actively considering the adoption of points-based systems. In the United States, the immigration reform debate has recently been dominated by question of how to deal with the large flow and stock of illegal migrants. However, the U.S. did significantly expand the

availability of temporary H-1B visas for the highly skilled in the late 1990s and early 2000s.¹³ And although the bursting of the high tech bubble (and post-September 11, 2001 security concerns) undermined the constituency for renewing the expanded cap after it expired in 2003, fears of an under-supply of skilled workers is leading to calls to reduce restrictions on the recruitment of foreign talent.¹⁴ In May of 2007, the United States Senate began debate on a comprehensive immigration reform bill that includes a points-based system for selecting skilled immigrants. Although this legislation ultimately failed, this policy proposal represents a significant shift from the current emphasis on family reunification as the basis for selecting a large majority of permanent immigrants.

With this level of policy interest, it is surprising that the question of the optimal design of a skill-focused immigrant selection system has not received more attention. This paper explores the optimal design question based on a very simple idea: a selection system can be devised based on a human capital-based earnings regression for predicting how potential immigrants will “perform” in the domestic labor market *and* a chosen predicted-earnings threshold for deciding whom to accept and reject. We show that these two elements are sufficient to determine the optimal point allocations for various bundles of human capital characteristics. The resulting framework also provides a systematic way of evaluating existing points systems and proposed reforms to those systems. Of course, the idea of giving points for observed human capital characteristics is the essential feature of existing systems. While the allocations of points in the Canadian and Australian systems, for example, are clearly informed by the findings from the

¹³ The cap was expanded from 65,000 to 195,000 visas per year.

¹⁴ See, for example, National Science Board (2004) and Florida (2005).

human capital literature, the allocation process appears to lack a firm analytical foundation. We hope this paper will provide that foundation.

We hasten to add that having high predicted earnings is a rather narrow basis for selecting immigrants. Most countries also place importance on reunifying families and protecting people fleeing persecution or humanitarian catastrophes. Even from a narrow economic perspective of those already present in the host country, a better measure of immigrant value is the “surplus” that the country gains from the immigrants. This surplus can be defined as the value the country receives less what they must pay to the immigrants. Simple models show that it is not necessarily the most highly skilled immigrants that generate the greatest surplus.¹⁵ However, the relevance of human capital is likely to increase when we allow for fiscal effects, knowledge spillovers, or the value of specialized skills. Augmenting the relative supply of skilled workers should also reduce overall earnings inequality, so that skilled recruitment can be desirable on both efficiency and equity grounds.¹⁶ But whatever the merits of focusing narrowly on skills, it is the case that a number of countries are striving to select more skilled and higher earning immigrant pools. It is thus worthwhile to look for a more systematic approach to designing a skills-based selection system.

¹⁵ See, for example, Borjas (1995), and McHale (2003).

¹⁶ George Borjas (1999, p. 19) makes the following case for focusing on immigrant skills:

If nothing else, decades of social science research have established an irrefutable link between human capital—a person’s endowment of ability and acquired skills—and a wide array of social and economic outcomes, ranging from earnings potential to criminal activity, work effort to drug abuse, and from family stability to life expectancy. In view of this strong link, it is not surprising that the United States cares about whether the immigrant population is composed of skilled or unskilled workers. The skill composition of the immigrant population—*and how the skills compare to those of natives*—determine the social and economic consequences of immigration for the country. [Emphasis in the original.]

We develop our method for identifying the optimal immigrant selection system as follows. In Section 3.2, we begin with a one-period horizon and an assumption that admitted immigrants would find employment to show the basic method for designing a points system for a given predicted-earnings threshold and a given prediction regression. We initially focus on linear points systems due to their ease of interpretability. We then show how the basic (linear) set-up can be extended to allow for more realistic multi-year horizons, immigrant assimilation, and an earnings threshold measured in terms of the present discounted value of the immigrant's predicted earnings stream. Finally, we discuss the possibility of non-employment and the implications of relaxing the requirement that the points system is linear.

The next two sections focus on the task of identifying the optimal threshold, which we model as a constrained optimization problem. In Section 3.3 we derive the selection frontier, which shows the tradeoff between immigrant quality and quantity and thus captures the constraint facing the policy maker. Each point on the frontier is shown to map to a unique predicted-earnings threshold. To identify the frontier, we model the admitted pool as a "selected sample," in the well defined sense that the pool is an incidentally truncated subset of the applicant pool. The truncation takes place on the basis of a comparison of predicted earnings and the predicted-earnings threshold. We show that the location of the frontier depends on the mean and variance of log earnings in the (lognormally distributed) applicant pool, and also the variance of the prediction error for the log earnings regression. In other words, the policy maker is constrained by the nature of the applicant pool and also their ability to predict the labor market success of given applicants. In Section 3.4, we add an illustrative specification of policy-maker preferences. We assume that the policy maker values immigrant human capital but faces a convex adjustment cost of adjusting to immigration. The optimal threshold is identified as the policy maker's most

preferred point on the selection frontier. Section 3.5 provides our concluding comments and outlines our procedure to the design and evaluation of actual points systems, which we implement in Chapter 4.

3.2 Basic Points System Design

In this section, we describe how a points system can be designed using a human capital-based earnings regression for predicting applicant “success” (i.e. predicted earnings, \hat{Y}_i) in the host-country labor market combined with a designated predicted earnings threshold, \hat{Y}^* .¹⁷ As noted in the introduction, the key idea is that applicants with predicted earnings above the threshold are accepted; all others rejected. We initially restrict attention to linear points systems, which in turn restricts us to using additively separable functional forms for the earnings regression. (A linear system gives the total points by simply adding up the points per unit of each human capital characteristic.) The earnings regression is additively separable if there is some monotonically increasing transformation that yields a right-hand side that is linear in the variables.

(i) One-period horizon and certain employment

To focus on the essential elements, we start with a very simple earnings regression, certain employment, and a one-period horizon for time spent in the host-country labor market.

¹⁷ It is worth noting that there are other bases for establishing a points system. Immigrants could be selected via points systems based on linear discriminate analysis, logistic regression, or multi-criteria optimization amongst other methods. We selected our method because of its simplicity, ability to model a continuous measure of success and the direct interpretability of results with respect to a relevant policy variable.

There are just two human capital indicators for a potential immigrant, i : years of schooling (S_i) and years of experience at landing (E_i), and the additive separable earnings regression is assumed to take the familiar log-linear (or semi-log) form,

$$(1) \quad \ln Y_i = y_i = \beta_0 + \beta_1 S_i + \beta_2 E_i + u_i \quad u_i \sim n(0, \sigma_u^2).$$

The equation is estimated by OLS, yielding an equation for what we assume is the best-linear-unbiased predictor of earnings for potential immigrant i ,

$$(2) \quad \hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 S_i + \hat{\beta}_2 E_i.$$

Equation (2) is an equation for predicted log earnings ($\hat{y}_i = \hat{\ln} Y_i$). However, what we need is the log of predicted earnings ($\ln \hat{Y}_i$). A consistent estimate of the log of predicted earnings is calculated by adding an adjustment factor $\sigma_u^2 / 2$ to the predicted log earnings¹⁸ to obtain the approximation,

$$(3) \quad \ln \hat{Y}_i \approx \frac{\sigma_u^2}{2} + \hat{y}_i = \frac{\sigma_u^2}{2} + \hat{\beta}_0 + \hat{\beta}_1 S_i + \hat{\beta}_2 E_i.$$

We now slightly rearrange the equation (and henceforth ignore the approximation) to obtain,

¹⁸ See, for example, Goldberger (1968) and for a discussion on this adjustment factor.

$$(3') \quad \ln \hat{Y}_i - \frac{\sigma_u^2}{2} - \hat{\beta}_0 = \hat{\beta}_1 S_i + \hat{\beta}_2 E_i.$$

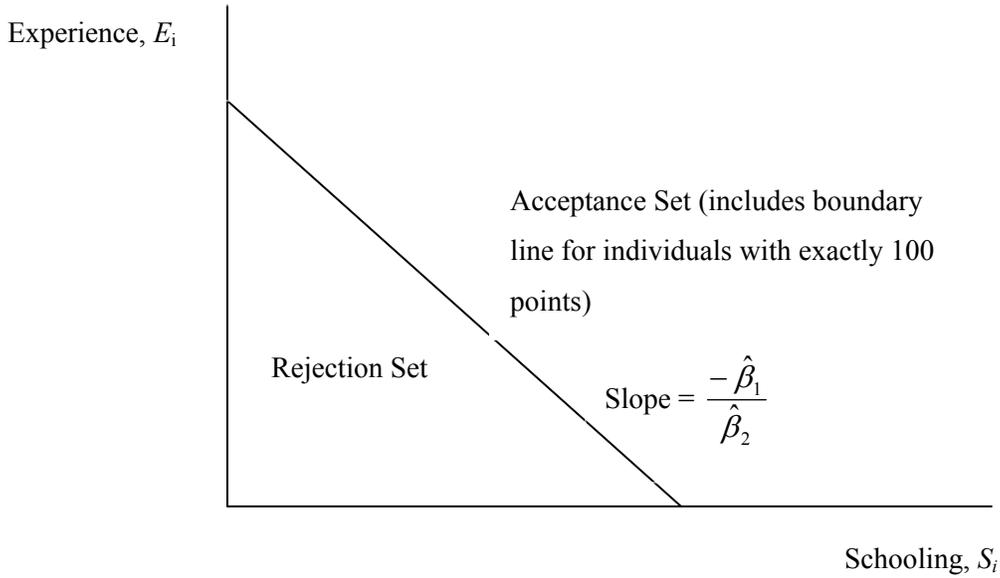
Finally, we rescale so that the left-hand side of (3') is equal to an arbitrarily chosen 100 points when predicted earnings exactly equal the predicted-earnings threshold, $\hat{Y}_i = Y^*$.

$$(4) \quad \frac{100\bar{\beta}}{\beta} = \left(\frac{100\hat{\beta}_1}{\bar{\beta}} \right) S_i + \left(\frac{100\hat{\beta}_2}{\bar{\beta}} \right) E_i,$$

$$\text{where} \quad \bar{\beta} = \ln Y^* - \frac{\sigma_u^2}{2} - \hat{\beta}_0.$$

In this form, the coefficients on the schooling and experience variables give the number of points that should be granted per unit of schooling and experience respectively. Applicants who score 100 points or more (or equivalently have predicted earnings greater than the threshold, Y^*) are accepted; applicants who score less than 100 points are rejected. The combinations of schooling and experience that result in exactly 100 points are shown by the boundary line in Figure 3.1. The relative value of an additional year of schooling in terms of years of experience is given by the slope of the boundary line. The figure also shows which bundles of human capital characteristics lead to acceptance and which lead to rejection.

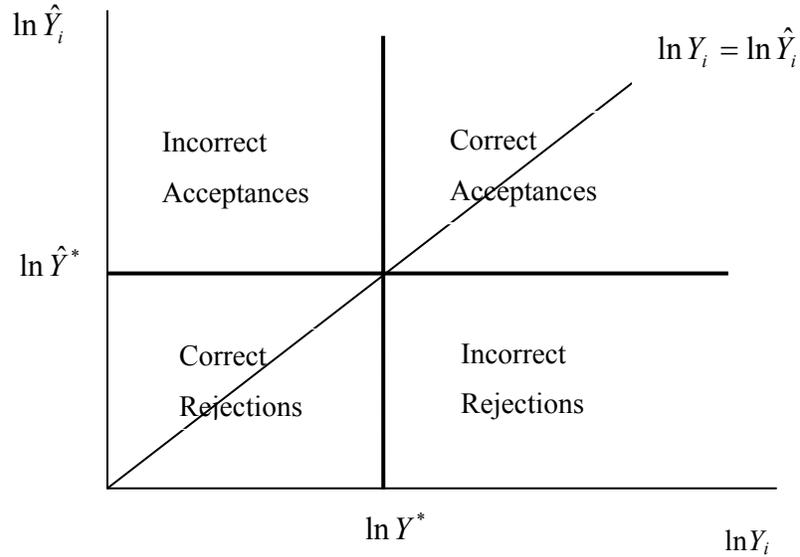
Figure 3.1



Clearly, the success of any such points system depends on the predictive success of the earnings regression. As is well known, prediction errors can result from biased estimators of the coefficients, sampling error in the estimated coefficients, measurement error in the explanatory variables, and random disturbances in actual earnings. Figure 3.2 graphically shows how prediction errors will lead to “mistakes” in the immigrant screening process.¹⁹

¹⁹ In Sections 3.3 and 3.4 we make the simplifying assumptions that the true earnings regression is known and the human capital variables that the immigration authorities observe are measured without error. Thus the first three sources of error mentioned above are conveniently not present, and we focus on the variance of the disturbance term (which under these simplifying assumptions is equal to the variance of the prediction error) as the key determinant of the success of the screening process for any given applicant pool and predicted earnings threshold. We return to the issue of specifying and estimating the prediction regression given multiple sources of error in Section 3.5.

Figure 3.2



(ii) *Allowing for a multi-period horizon*

An obvious limitation of this simple model is that immigrants will typically be present in the host-country labor market for longer than a single year. This will force the policy maker to consider a threshold for the present discounted value of the predicted earnings stream rather than a single year's predicted earnings. Predicted earnings for later years will be affected by how the immigrants earnings evolve with time spent in the host-country labor market. The simplest possible modification of our basic case is to add a years-since-migration variable, t_i , to our basic framework. The revised earnings regression is,

$$(5) \quad \ln Y_{it} = \beta_0 + \beta_1 S_i + \beta_2 E_i + \beta_3 t_i + u_{it} \quad u_{it} \sim n(0, \sigma_u^2).$$

Again using OLS to obtain the best-linear-unbiased predictor of earnings and the approximation used above, we can write the log of predicted earnings as,

$$(6) \quad \ln \hat{Y}_{it} \approx \hat{y}_{it} + \frac{\sigma_{\hat{u}}^2}{2} = \hat{\beta}_0 + \hat{\beta}_1 S_i + \hat{\beta}_2 E_i + \hat{\beta}_3 t_i + \frac{\sigma_{\hat{u}}^2}{2}.$$

Assuming a time horizon of T_i years and a discount rate of δ , we use (6) to write the present discounted value of earnings as,

$$(7) \quad \begin{aligned} \hat{Z}_i &= \int_0^{T_i} e^{-\delta t_i} \hat{Y}_{it} dt_i \\ &= e^{\frac{\sigma_{\hat{u}}^2}{2} + \hat{\beta}_0 + \hat{\beta}_1 S_i + \hat{\beta}_2 E_i} \int_0^{T_i} e^{(\hat{\beta}_3 - \delta)t_i} dt_i \\ &= e^{\frac{\sigma_{\hat{u}}^2}{2} + \hat{\beta}_0 + \hat{\beta}_1 S_i + \hat{\beta}_2 E_i} \left(\frac{1}{\hat{\beta}_3 - \delta} \right) \left(e^{(\hat{\beta}_3 - \delta)T_i} - 1 \right) \end{aligned}$$

For now, we can preserve linearity in the points system if we approximate the last term in parentheses by $e^{(\hat{\beta}_3 - \delta)T_i}$. (That is, we simply ignore the fact that 1 is subtracted from this term, which should be a reasonable approximation for longer horizons). In Chapter 4, we will remove this approximation.²⁰ Using this approximation and taking logs yields,

$$\ln \hat{Z}_i \approx \frac{\sigma_{\hat{u}}^2}{2} + \hat{\beta}_0 + \hat{\beta}_1 S_i + \hat{\beta}_2 E_i - \ln(\hat{\beta}_3 - \delta) + (\hat{\beta}_3 - \delta)T_i.$$

²⁰ Removing this approximation leads to a system where points are allocated linearly to human capital characteristics with a non-linear penalty for age.

We further assume that the immigrant will work until age \bar{A} , so that $T_i = \bar{A} - A_i$, where A_i is age at arrival. Now letting our threshold for the present discounted value of the predicted earnings stream equal Z^* (and again imposing a points cut off of 100 and ignoring the approximations), we can write our key points equation as,

$$\frac{100\tilde{\beta}}{\tilde{\beta}} = \left(\frac{100\hat{\beta}_1}{\tilde{\beta}} \right) S_i + \left(\frac{100\hat{\beta}_2}{\tilde{\beta}} \right) E_i - \left(\frac{100\hat{\beta}_3 - \delta}{\tilde{\beta}} \right) A_i, \quad (8)$$

$$\text{where } \tilde{\beta} = \ln Z^* - \frac{\sigma_i^2}{2} - \hat{\beta}_0 + \ln(\hat{\beta}_3 - \delta) - (\hat{\beta}_3 - \delta)\bar{A}.$$

Once again, the terms in parentheses on the right-hand-side provide the points per unit of the human capital characteristic. The key difference between (8) and (4) is that (8) allows for a points penalty based on the age of the applicant (reflecting the fact that older applicants will have fewer years of earnings in the host-country labor market).

(iii) Allowing for non-employment

Up to this point, we have assumed all immigrants are employed in the host economy and have focused on developing a log-linear model for predicted earnings conditional on that employment. However, immigrant non-employment is likely to be a significant concern for various reasons—lengthy job search in an unfamiliar labor market, non-recognition of immigrant credentials, poorly transferable skills, etc. If we continue to use predicted earnings as the basis for selection, the obvious extension to our model is to treat predicted (unconditional) earnings (\hat{Y}_{it}^u) as the product of the predicted probability of employment in year t (\hat{J}_{it}) and predicted

earnings conditional on employment (\hat{Y}_{it}). Taking logs, we have an amended predicted earnings equation: $\ln \hat{Y}_{it}^u = \ln \hat{J}_{it} + \ln \hat{Y}_{it}$. Based on the vast literature on empirical earnings functions, we have argued that a log-linear specification is defensible for modeling the determinants of $\ln \hat{Y}_{it}$. This is what allowed us develop a user-friendly linear points system. But additive separability is much harder to defend for the probability of employment. If, for example, we let $J_{it} = e^{\alpha_0 + \alpha_1 S_i + \alpha_2 E_i}$, then taking logs of both sides clearly gives us the necessary linear right-hand side: $\ln J_{it} = \alpha_0 + \alpha_1 S_i + \alpha_2 E_i$. But a log-linear specification is unlikely to be defensible for modeling the probability of employment. One obvious limitation is that the probability of employment can exceed unity. Of course, more standard models of this probability, such as probit or logit, do not produce the necessary linearity after the log transformation. This forces us to balance the costs of restrictive functional forms against the simplicity of linearity.²¹

Taking stock, our approach thus far has been to assume a given (optimal) earnings threshold and an (optimal) predication regression, and then to derive the optimal points system. The next two sections focus on how the selection frontier and optimal threshold are determined.

²¹ Note also that even though the use of the log-linear functional form is standard for earnings functions (conditional on employment), our requirement of additive separability rules out interaction and higher order terms (e.g. experience squared) as additional explanatory variables. Given the ubiquity of such terms in estimated earnings regressions, such exclusions are likely to be quite restrictive. Thus we may wish to abandon the simplicity of a linear points system even without the complication of the possibility of non-employment. This raises the broader question of how important it is that the points system is linear. Clearly, a linear system is user friendly, as potential applicants can easily understand how their points total is arrived at, and also what they would need to do to increase their score. On the other hand, even highly non-linear systems can be made reasonably user friendly through the use of an on-line points calculator. The potential applicant could enter a set of characteristics, and the calculator would reveal the points score based on the predicted earnings for someone with those characteristics. The decision about adopting a non-linear system would involve a tradeoff between lost simplicity and improved predictions. The systematic approach to points-system design we develop in this paper has the virtue of allowing designers to explore how predictions are improved when non-linearities are allowed.

3.3 Derivation of the Selection Frontier

The optimal threshold is determined as the result of a constrained optimization problem, where the constraint – what we term the selection frontier – is the tradeoff between the mean earnings of the admitted pool and number of immigrants admitted. Each point on the frontier maps to a unique predicted-earnings threshold. In this section, we derive the selection frontier and explore the factors that affect its position. In the next section, we examine how the optimal point on the frontier is chosen.

Under our points system, prospective immigrants are accepted or rejected on the basis of points which reflect their expected earnings. Those who are rejected do not produce earnings in the receiving country and therefore do not contribute to the mean earnings of the immigrant pool. Thus the selection frontier is developed as a variant of incidental truncation of immigrant earnings. In this case, the earnings variable is truncated based on a forecast of earnings, not its actual value. In deriving the selection frontier, we assume that actual (post-entry) earnings are lognormally distributed across the applicant pool. In addition, we assume that the earnings prediction errors that result from the earnings regression are lognormally distributed. Together these assumptions imply that actual earnings and predicted earnings have a joint lognormal distribution with a correlation coefficient equal to the square root of the coefficient of determination (R^2) from the earnings regression.²²

²² Using notation described in the main text the relationship between log earnings, predicted log earnings and the residual is: $y_i = \hat{y}_i + \hat{u}_i$ since $V(y) = V(\hat{y}) + V(\hat{u})$, it follows that $\hat{y} \sim N(\mu_y, \sigma_y^2 - \sigma_u^2)$.

The first step in deriving the frontier is to determine the mean earnings of the admitted pool for any given earnings threshold. To do this, we treat the admitted pool as resulting from the incidental truncation of the applicant pool, where the applicant is admitted if their predicted earnings, \hat{Y} , is greater than a policy-determined earnings threshold of Y^* (where i subscripts are now dropped for notional convenience). The mean earnings of the admitted pool with the general probability density function (PDF) $f(\cdot)$ is given by,

$$(9) \quad E[Y | \hat{Y} \geq Y^*] = E[Y | \hat{y} \geq y^*] = \int_{y^*}^{\infty} E[Y | \hat{y} = x] \frac{f(x)}{1 - P(x \leq y^*)} dx.$$

We apply this general specification to our model by substituting in the conditional estimate of earnings based on the estimator of log earnings that was introduced in the previous section: $E[Y | \hat{y} = x] \approx e^{\sigma_a^2/2} e^x$. We also substitute the normal PDF, for the general density function $f(\cdot)$ to yield the conditional expectation:²³

$$(10) \quad E[Y | \hat{y} \geq y^*] = \frac{1}{P[\hat{Y} \geq Y^*]} \int_{y^*}^{\infty} \frac{1}{\sigma_{\hat{y}} \sqrt{2\pi}} e^{\sigma_a^2/2} e^{-\frac{(x - \mu_{\hat{y}})^2}{2\sigma_{\hat{y}}^2}} e^x dx.$$

Collecting like terms and completing the square in the exponents yields:

²³ To establish notation, we will frequently use $\phi(\cdot)$ to denote the standard normal PDF and $\Phi(\cdot)$ to denote the standard normal cumulative distribution (CDF).

$$(11) \quad E[Y | \hat{y} \geq y^*] = \frac{e^{\sigma_y^2/2} e^{(-\mu_{\hat{y}} + (\sigma_{\hat{y}}^2 + \mu_{\hat{y}})^2)/2\sigma_{\hat{y}}^2}}{1 - \Phi(z(\hat{y}^*))} \int_{\xi}^{\infty} \frac{1}{\sigma_{\hat{y}} \sqrt{2\pi}} e^{-[(v - \mu_{\hat{y}}/\sigma_{\hat{y}})^2/2]} dv.$$

Integrating and substituting in the standard normal transformation, $z_{\hat{y}}(k) = \left(\frac{k - \mu_{\hat{y}}}{\sigma_{\hat{y}}}\right)$ and the

fact that $e^{\frac{\sigma_y^2}{2}} = e^{\frac{\sigma_{\hat{y}}^2}{2}} e^{\frac{\sigma_y^2}{2}}$ yields:²⁴

$$(12) \quad E[Y | \hat{y} \geq y^*] = e^{\sigma_y^2/2} e^{\mu_{\hat{y}}} \left[\frac{1 - \Phi(z_{\hat{y}}(y^* - \sigma_{\hat{y}}^2))}{1 - \Phi(z_{\hat{y}}(y^*))} \right].$$

For the final step we use the fact that $z_{\hat{y}}(y^*) - \sigma_{\hat{y}} = z_{\hat{y}}(y^* - \sigma_{\hat{y}}^2)$ to obtain:

$$(13) \quad E[Y | \hat{y} \geq y^*] = \bar{Y} \left[\frac{1 - \Phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})}{1 - \Phi(z_{\hat{y}}(y^*))} \right],$$

where \bar{Y} is the mean earnings of the applicant pool. With this parsimonious equation for the mean earnings of the admitted pool, we can determine how the “quality” of the admitted pool changes with the predicted-earnings threshold.

*Proposition 1: The mean earnings of the admitted pool is increasing in the predicted-earnings threshold.*²⁵

²⁴ See Appendix B for additional details on steps from (10) to (13).

²⁵ See Appendix A for additional details on the proof.

Proof:

Many of our proofs will follow the form of calculating a partial derivative of the conditional expectation function and then characterizing its sign. In this case, we will characterize the partial derivative of the mean earnings with respect to the cutoff earnings:

$$(14) \quad \frac{\partial E[Y | \hat{y} \geq y^*]}{\partial y^*} = \bar{Y} \left[\frac{-\phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})(1 - \Phi(z_{\hat{y}}(y^*))) + \phi(z_{\hat{y}}(y^*))(1 - \Phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}}))}{\sigma_{\hat{y}}(1 - \Phi(z_{\hat{y}}(y^*)))^2} \right].$$

Since the mean earnings of the candidate pool, \bar{Y} , and the denominator of the fraction are both positive, the sign depends on the numerator of the quotient. The mean earnings of the admitted pool will increase in the earnings threshold if and only if:

$$(15) \quad \phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})(1 - \Phi(z_{\hat{y}}(y^*))) < \phi(z_{\hat{y}}(y^*))(1 - \Phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})).$$

Since $\phi(\cdot)$ is the standard normal PDF and $\Phi(\cdot)$ is the standard normal CDF, this condition can be expressed in terms of normal hazard rate functions:

$$(16) \quad \frac{\phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})}{1 - \Phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})} < \frac{\phi(z_{\hat{y}}(y^*))}{1 - \Phi(z_{\hat{y}}(y^*))}.$$

The fact that $\sigma_{\hat{y}} > 0$ and the normal hazard rate is an increasing function completes the proof. \square

The second step in deriving the selection frontier is to determine the relationship between the percentage of immigrants admitted and the predicted earnings threshold. We define the share of candidates admitted as $p = N/T$, where N is the number admitted and T is the total pool size. Candidates are admitted when their predicted earnings exceeds the predicted-earnings threshold, Y^* . Given the lognormal distribution of earnings in the applicant pool, the expected share of applicants admitted for any given threshold in log earnings is that share of applicants whose incomes exceed the threshold:

$$(17) \quad p = 1 - \Phi(z_{\hat{y}}(y^*)).$$

Proposition 2: The share of the applicant pool that is admitted is decreasing in the predicted-earnings threshold.

Proof: This follows directly from the monotonicity of the $z_{\hat{y}}(\cdot)$ and the fact that $\Phi(\cdot)$ is a CDF. \square

We are now in a position to derive the selection frontier. Since $z_{\hat{y}}(\cdot)$ and $\Phi(\cdot)$ are positive monotonic functions, we can invert them and make a minor rearrangement of (17) to obtain:

$$(18) \quad y^* = z_{\hat{y}}^{-1}(\Phi^{-1}(1-p)).$$

This establishes a one-to-one relationship between a cutoff threshold and share of the applicant pool that is admitted. We next subtract $\sigma_{\hat{y}}^2$ from both sides and transform both sides by $z_{\hat{y}}(\cdot)$ and use the fact that $z_{\hat{y}}(y^*) - \sigma_{\hat{y}} = z_{\hat{y}}(y^* - \sigma_{\hat{y}})$ to obtain:

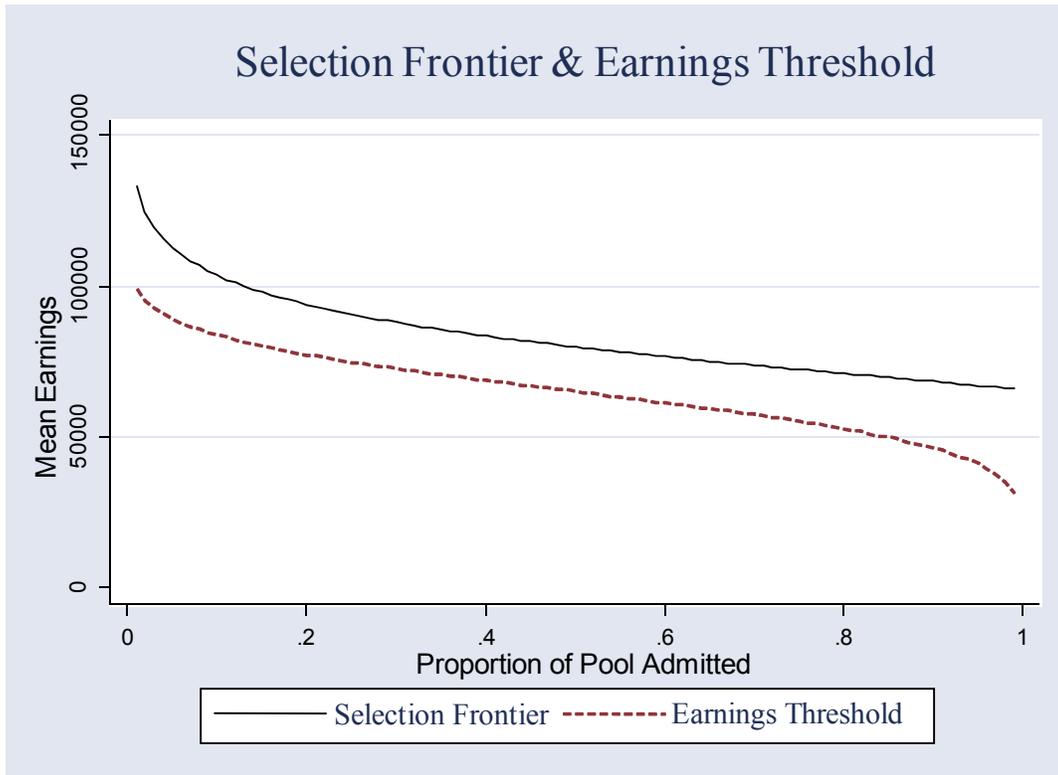
$$(19) \quad z_{\hat{y}}(y^*) - \sigma_{\hat{y}} = z_{\hat{y}}(z_{\hat{y}}^{-1}(\Phi^{-1}(1-p)) - \sigma_{\hat{y}}).$$

We substitute (19) into (13) and work through the $z_{\hat{y}}(\cdot)$ and $z_{\hat{y}}^{-1}(\cdot)$ transformations to obtain an equation for the selection frontier.

$$(20) \quad E[Y | p] = \frac{\bar{Y}}{p}(1 - \Phi(\Phi^{-1}(1-p) - \sigma_{\hat{y}})).$$

The selection frontier and the associated predicted-earnings thresholds are shown in Figure 3.3. For illustrative purposes, the mean earnings of the applicant pool, \bar{Y} has been set to \$65,000. In addition, σ_y^2 and σ_u^2 are set to 0.4 and 0.32 respectively which imply that the R^2 from the earnings regression is equal to 0.20 – a number that is consistent with earnings regressions.

Figure 3.3



The selection frontier shows how the “quality” of the admitted pool declines as a larger share of the applicant pool is admitted, where it is assumed that the best possible method of predicting earnings is being utilized. As expected, as we move towards admitting all applicants, the mean earnings of the admitted pool converges to the mean earnings of the applicant pool. The lower curve shows the relationship between the predicted earnings threshold and the proportion of the pool admitted. Together these curves illustrate how a predicted earnings threshold would be established. If the country chooses the point on the selection frontier where 25% of the pool will be admitted, yielding mean earnings of \$90,500 for successful candidates, the implied earnings threshold would be \$75,000.

We next confirm that the selection frontier is strictly downward sloping, so that the admission of a larger share of the applicant pool (which is achieved by lowering the earnings threshold) is associated with a decline in the mean earnings of the admitted pool.

*Proposition 3: The mean earnings of the admitted pool decreases with the share of applicant pool admitted.*²⁶

Proof:

This time we take the partial derivative of the selection frontier function with respect to price and show that it is always negative.

$$(21) \quad \frac{\partial E[Y | p]}{\partial p} = -\frac{\bar{Y}}{p} \left(\frac{(1 - \Phi(\Phi^{-1}(1-p) - \sigma_{\hat{y}}))}{p} + \frac{\phi(\Phi^{-1}(1-p) - \sigma_{\hat{y}})}{\phi(\Phi(1-p))} \right)$$

This partial derivative will be negative if:

$$(22) \quad \frac{\phi(\Phi^{-1}(1-p) - \sigma_{\hat{y}})}{1 - \Phi(\Phi^{-1}(1-p) - \sigma_{\hat{y}})} < \frac{\phi(\Phi^{-1}(1-p))}{p}$$

Let $x = \Phi^{-1}(1-p)$, rearranging we get $p = 1 - \Phi(x)$. Substituting these into (22) allows us to express the constraint in terms of hazard rate functions:

²⁶ See Appendix A for additional details on the proof.

$$(23) \quad \frac{\phi(x - \sigma_{\hat{y}})}{1 - \Phi(x - \sigma_{\hat{y}})} < \frac{\phi(x)}{1 - \Phi(x)}.$$

As before, the fact that the normal hazard rate is an increasing function completes the proof. \square

The selection frontier determines the quality-quantity tradeoff available to policy makers. We next examine the factors that determine the position of the frontier. Given our lognormality assumptions, the position of the frontier is determined by just three parameters: the mean earnings of the applicant pool (\bar{Y}), the variance of earnings in the applicant pool (σ_y^2), and the variance of the prediction error (σ_u^2).

Proposition 4: The selection frontier is shifted upwards by an increase in the mean earnings of the applicant pool.

Proof:

Here we show that the partial derivative of the selection frontier function with respect to mean earnings of the candidate pool is positive.

$$(24) \quad \frac{\partial E[Y | p]}{\partial \bar{Y}} = \frac{1}{p} (1 - \Phi(\Phi^{-1}(1 - p) - \sigma_{\hat{y}})).$$

Because p is positive and the $\Phi(\cdot)$ function is bounded above by 1, the value of this partial derivative is positive for all values of p . Thus an increase in \bar{Y} results in higher earnings for

accepted candidates at each value of p and is therefore associated with an upward shift of the selection frontier. \square

Proposition 5: The selection frontier is shifted upwards by an increase in the variance of earnings in the applicant pool and shifted downwards by an increase in the variance of the prediction error.

Proof:

For this proof, it is more convenient to work with the variances rather than the standard deviations. Since neither σ_y nor σ_u appear in the formula for the selection frontier, we must substitute them in and then characterize the appropriate partial derivatives. Recall the formula for the selection frontier given by equation (20):

$$(20) \quad E[Y | p] = \frac{\bar{Y}}{p} (1 - \Phi(\Phi^{-1}(1 - p) - \sigma_{\hat{y}})).$$

We then replace $\sigma_{\hat{y}}$ using the identity $\sigma_{\hat{y}} = (\sigma_y^2 - \sigma_u^2)^{1/2}$ we get:

$$(25) \quad E[Y | p] = \frac{\bar{Y}}{p} (1 - \Phi(\Phi^{-1}(1 - p) - (\sigma_y^2 - \sigma_u^2)^{1/2})).$$

From this, we determine the partial derivatives with respect to σ_y .

$$(26) \quad \frac{\partial E[Y | p]}{\partial \sigma_y} = \frac{\bar{Y}}{p} (\phi(\Phi^{-1}(1-p) - (\sigma_y^2 - \sigma_u^2)^{1/2}) - \frac{\sigma_y}{(\sigma_y^2 - \sigma_u^2)^{1/2}}) + \frac{\partial \bar{Y}}{\partial \sigma_y} (1 - \Phi(\Phi^{-1}(1-p) - (\sigma_y^2 - \sigma_u^2)^{1/2})).$$

This equation is the sum of two components, each of which is positive. The first component is the product of a three terms, each of which can be seen to be positive. The second component is a product of two positive terms. The first partial derivative of immigrant pool's earnings with respect to the standard deviation of log earnings, $\frac{\partial \bar{Y}}{\partial \sigma_y} = \frac{\sigma_y \bar{Y}}{2}$ which is clearly positive. The rest of the term is 1 minus a point on the normal CDF. Since the CDF is bounded above by 1, the whole term is greater than 0. Since both components of the sum are positive, the total must be positive and as a result, the mean earnings for successful candidates increase with an increase in variance.

Repeating this analysis for the partial derivative with respect to variance of the prediction error σ_u^2 is quite a bit simpler:

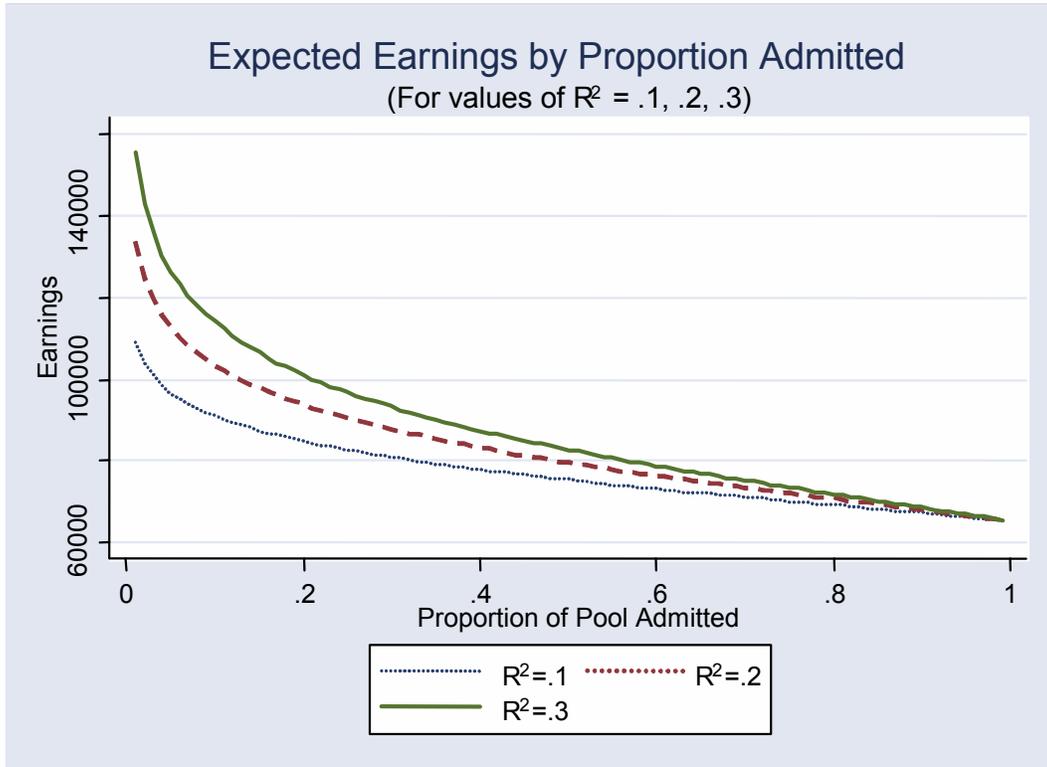
$$(27) \quad \frac{\partial E[Y | p]}{\partial \sigma_u^2} = -\frac{\bar{Y}}{p} (\phi(\Phi^{-1}(1-p) - \sigma_y) \frac{\sigma_u}{\sigma_y}).$$

Since income \bar{Y} proportion admitted p are positive $\phi(\cdot)$ is a normal PDF and the ratio of two standard errors must be positive, the leading negative sign renders the entire expression negative.

Consequently, the mean earnings of successful candidates falls with an increases in prediction error. □

Figure 3.4 shows the selection frontier for different values of the R^2 from the earnings regression (recalling that $R^2 = 1 - \frac{\sigma_{\hat{u}}^2}{\sigma_y^2}$). A reduction in the variance of the prediction error will raise the R^2 and shift the selection frontier upwards. As shown in the graph, the mean earnings of the admitted pool of immigrants increases more in response to improved forecasts when a small proportion of the applicant pool is admitted. In other words, the benefits of better prediction increase as the system becomes more selective.

Figure 3.4



3.4 Choice of the Predicted-Earnings Threshold: An Illustrative Example

Our focus to this point has been the determination of the selection frontier facing policy makers. We now turn briefly to the question of how policy makers should choose which point on the frontier to operate on; that is, how they choose the predicted-earnings threshold. The chosen point will depend on the willingness of policy makers to trade off immigrant “quality” for “quantity,” which in turn will depend on the details of how skilled immigration affects the economy and politics of recruiting foreign workers. Rather than attempt to provide a detailed model of the determinants of policy-maker preferences, we limit ourselves here to an illustrative example of the tradeoffs that are likely to be involved. The essence of the example is that policy makers like immigrant human capital but face a convex cost in adjusting to immigration.

Letting q denote the average quality (as measured by the mean earnings) of the admitted pool and N the total number of immigrants admitted, we can write the total human capital of the admitted pool as $q \times N$. We assume that policy makers place a value of a on a unit of human capital (which we take to be measured by a dollar of earnings). There is also a cost to immigration that is a convex function of the number of immigrants. To model this, we will use $(b/2)N^2$. Total policy maker utility is thus,

$$(28) \quad U = aqN - \frac{b}{2}N^2.$$

The resulting policy-maker indifference curves in quality-quantity space will be U-shaped in quantity-quality space (see Figure 3.5). This implies that over a certain range a fall in

quality can be compensated by an increase in quantity; however, once the level of immigration reaches a certain level, further immigration must be compensated by an increase in quality. More specifically, the slope of an indifference curve through a given point is given by,

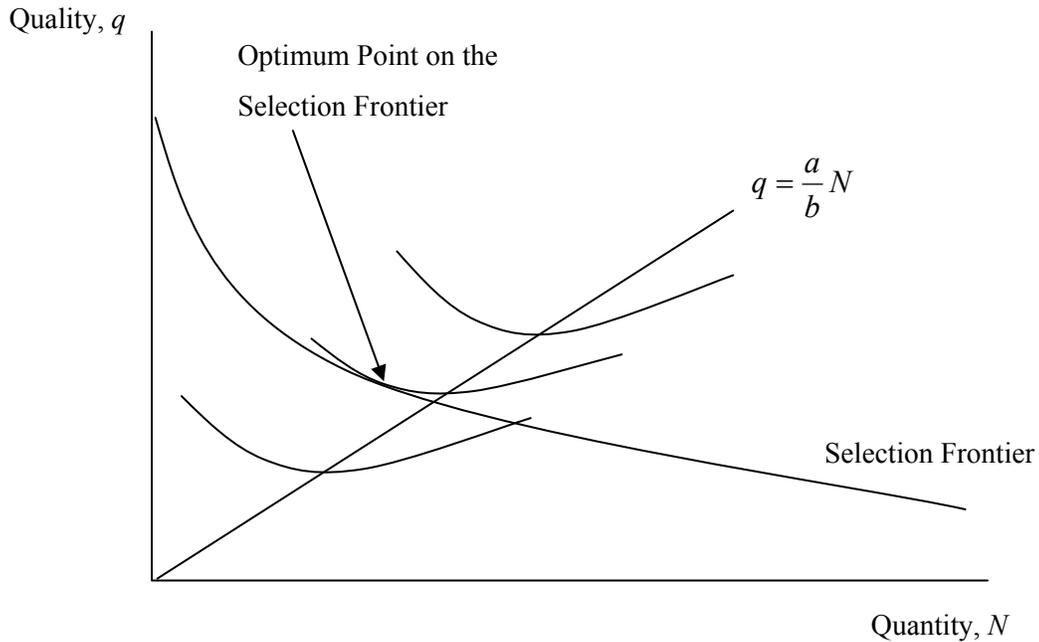
$$(29) \quad \frac{dq}{dN} = \frac{bN - aq}{aN}.$$

An indifference curve will reach its minimum point when the numerator is equal to zero. Thus the set of minimum points as we move to higher and higher indifference curves will rise along the linear schedule,

$$(30) \quad q = \frac{b}{a} N.$$

Figure 3.5 illustrates how the policy maker chooses the predicted-earnings threshold by reaching the highest feasible indifference given the selection frontier.

Figure 3.5



Although the constraint imposed by the selection frontier is non-concave, we show in Appendix C that there exists a unique solution to this constrained-optimization problem. Finally, as demonstrated in Section 3.4, this optimal point on the frontier maps to a unique predicted-earnings threshold (see also Figure 3.3). The combination of this optimal threshold and the “optimal” prediction regression (see Chapter 4) are sufficient to identify the optimal immigrant selection system.

3.5 Concluding Comments

This paper has explored a simple idea for designing a more rational skills-based immigration points system. This idea is to systematically use the information available from

state-of-art human capital earnings regressions to predict a potential immigrant's success and to choose predicted-earnings threshold below which applicants are rejected. Our approach is motivated by the apparent desire among policy makers to select immigrants based on their likely labor market success, which explains the focus on human capital indicators in existing selection systems. However, the findings from human capital research have heretofore been applied to selection system design in a seemingly ad hoc way. Our proposed approach provides an objective basis for the evaluation of existing points systems, reforms to those systems, and the design of new systems. It promises to also provide a useful link between the burgeoning work on the determinants of immigrant labor market success and the growing interest in the improved design of immigrant selection policies.

Not everyone is convinced that the details of a skills-based immigrant selection system are of first-order importance in admitting economically successful immigrants. In a recent paper, Jasso and Rosenzweig (2005) stress the importance of immigrant *self* selection over the details of the selection system itself. They compare the immigrants admitted by the Australian system—which utilizes a points system to select on the basis of skills—to the immigrants admitted by the employer-driven U.S. system, and conclude there is no evidence that differences in the selection mechanism play any significant role in affecting the characteristics of the skilled immigrant streams. Our design approach clearly separates out the two major drivers of selection: the characteristics of the applicant pool (which Jasso and Rosenzweig find to dominate) and the way that selections are made from that pool, thus allowing us to evaluate the benefits of a points system (and fine-tuning that points system) in a systematic way. One common objection to points-based system stresses that employers are much better positioned to screen potential immigrants than a crude points grid. However, there is no reason why existing host-country

employment or firm job offers cannot be heavily weighted in a points system, as is now the case, for example, in the Australian and New Zealand systems. This is the kind of question that our approach is ideally suited to study.

In Chapter 4, we implement the design methods developed in this paper to study points systems for specific Canada. The ideal datasets for this purpose have detailed information on immigrant characteristics at the time of application (characteristics that would be observable to points-system administrators), and also information on wages and employment post-arrival to allow us to identify the characteristics that predict immigrant success. Canada's Immigrant Database (IMDB) is an ideal candidate, as it links information on characteristics at arrival to subsequent tax records. Although relatively new, the New Immigrant Survey (NIS) also combines data on the characteristics of immigrants to the U.S. with longitudinal data on their performance.

3.6 Appendix A – Details on Proofs

Proposition 1: The mean earnings of the admitted pool is increasing in the predicted –earnings threshold.

Starting with the formula for mean earnings conditional on admission:

$$(A1) \quad E[Y | \hat{y} \geq y^*] = \bar{Y} \left[\frac{1 - \Phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})}{1 - \Phi(z_{\hat{y}}(y^*))} \right],$$

$$(A2) \quad \frac{\partial E[Y | \hat{y} \geq y^*]}{\partial y^*} = \bar{Y} \left[\frac{-\phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})}{\sigma_{\hat{y}}(1 - \Phi(z_{\hat{y}}(y^*)))} + \frac{\phi(z_{\hat{y}}(y^*))(1 - \Phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}}))}{\sigma_{\hat{y}}(1 - \Phi(z_{\hat{y}}(y^*)))^2} \right],$$

$$(A3) \quad = \bar{Y} \left[\frac{-\phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})(1 - \Phi(z_{\hat{y}}(y^*))) + \phi(z_{\hat{y}}(y^*))(1 - \Phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}}))}{\sigma_{\hat{y}}(1 - \Phi(z_{\hat{y}}(y^*)))^2} \right].$$

The denominator is positive so the sign depends on the numerator. It will be positive if:

$$(A4) \quad \phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})(1 - \Phi(z_{\hat{y}}(y^*))) < \phi(z_{\hat{y}}(y^*))(1 - \Phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})).$$

As shown in the main text, this can be rearranged as a condition on the normal hazard rate functions as given by equation (16) as used in the main text:

$$(16) \quad \frac{\phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})}{1 - \Phi(z_{\hat{y}}(y^*) - \sigma_{\hat{y}})} < \frac{\phi(z_{\hat{y}}(y^*))}{1 - \Phi(z_{\hat{y}}(y^*))}.$$

Proposition 3: The mean earnings of the admitted pool is decreasing in the share of applicant pool admitted.

$$(A5) \quad E[Y | p] = \frac{\bar{Y}}{p} (1 - \Phi(\Phi^{-1}(1-p) - \sigma_{\hat{y}})),$$

$$(A6) \quad \frac{\partial E[Y | p]}{\partial p} = -\frac{\bar{Y}}{p^2} (1 - \Phi(\Phi^{-1}(1-p) - \sigma_{\hat{y}})) - \frac{\bar{Y}}{p} (\phi(\Phi^{-1}(1-p) - \sigma_{\hat{y}}) D_p(\Phi^{-1}(1-p))).$$

By the Inverse Function Theorem:

$$(A7) \quad D_p(\Phi^{-1}(1-p)) = -\frac{1}{\phi(\Phi^{-1}(1-p))}.$$

Substituting (A7) into (A6) and simplifying we get equation (21) in the main text:

$$(21) \quad \frac{\partial E[Y | p]}{\partial p} = -\frac{\bar{Y}}{p} \left(\frac{(1 - \Phi(\Phi^{-1}(1-p) - \sigma_{\hat{y}}))}{p} - \frac{\phi(\Phi^{-1}(1-p) - \sigma_{\hat{y}})}{\phi(\Phi^{-1}(1-p))} \right).$$

3.7 Appendix B – Omitted Steps Between Equations (10) and (11)

The exponential component of the integrand in equation (10) is:

$$(B1) \quad = -\left(\frac{x - \mu_{\hat{y}}}{\sigma_{\hat{y}}}\right)^2 / 2 + x,$$

$$(B2) \quad = -\left(\frac{x - (\mu_{\hat{y}} + \sigma_{\hat{y}}^2)}{\sigma_{\hat{y}}}\right)^2 / 2 + \frac{-\mu_{\hat{y}}^2 + (\mu_{\hat{y}} + \sigma_{\hat{y}}^2)^2}{2\sigma_{\hat{y}}^2}.$$

Substituting this back into (10) we get:

$$(B3) \quad = \frac{e^{\sigma_{\hat{y}}^2 / 2}}{1 - \Phi(z_{\hat{y}}(y^*))} \int_{y^*}^{\infty} \frac{1}{\sigma_{\hat{y}} \sqrt{2\pi}} e^{-(x - (\sigma_{\hat{y}}^2 + \mu_{\hat{y}}))^2 / 2\sigma_{\hat{y}}^2} e^{-\mu_{\hat{y}}^2 + (\sigma_{\hat{y}}^2 + \mu_{\hat{y}})^2 / 2\sigma_{\hat{y}}^2} dx.$$

Moving the constant through the integral:

$$(B4) \quad = \frac{e^{\sigma_{\hat{y}}^2 / 2} e^{-\mu_{\hat{y}}^2 + (\sigma_{\hat{y}}^2 + \mu_{\hat{y}})^2 / 2\sigma_{\hat{y}}^2}}{1 - \Phi(z_{\hat{y}}(y^*))} \int_{y^*}^{\infty} \frac{1}{\sigma_{\hat{y}} \sqrt{2\pi}} e^{-(x - (\sigma_{\hat{y}}^2 + \mu_{\hat{y}}))^2 / 2\sigma_{\hat{y}}^2} dx.$$

By defining $\xi = (\hat{y}^* - \sigma_{\hat{y}}^2)$ and using a change of variables to $v = (x - \sigma_{\hat{y}}^2)$ the second part of this expression becomes:

$$(B5) \quad \int_{y^*}^{\infty} \frac{1}{\sigma_{\hat{y}} \sqrt{2\pi}} e^{-(x - (\sigma_{\hat{y}}^2 + \mu_{\hat{y}}))^2 / 2\sigma_{\hat{y}}^2} dx = \int_{\xi}^{\infty} \frac{1}{\sigma_{\hat{y}} \sqrt{2\pi}} e^{-(v - \mu_{\hat{y}})^2 / 2\sigma_{\hat{y}}^2} dv.$$

The second component is just the definition of the normal PDF so:

$$(B6) \quad \int_{\xi}^{\infty} \frac{1}{\sigma_{\hat{y}} \sqrt{2\pi}} e^{-(v - \mu_{\hat{y}})^2 / 2\sigma_{\hat{y}}^2} dv = 1 - \Phi(\hat{y} - \sigma_{\hat{y}}^2).$$

Substituting this result into (B4) yields:

$$(B7) \quad E[Y | \hat{y} \geq y^*] = e^{\sigma_{\hat{y}}^2 / 2} e^{(-\mu_{\hat{y}}^2 + (\sigma_{\hat{y}}^2 + \mu_{\hat{y}})^2) / 2\sigma_{\hat{y}}^2} \left[\frac{1 - \Phi(z_{\hat{y}}(y^* - \sigma_{\hat{y}}^2))}{1 - \Phi(z_{\hat{y}}(y^*))} \right].$$

Collecting terms this simplifies to:

$$(B8) \quad E[Y | \hat{y} \geq y^*] = e^{\sigma_u^2/2} e^{\sigma_y^2/2} e^{\mu_y} \left[\frac{1 - \Phi(z_{\hat{y}}(y^* - \sigma_y^2))}{1 - \Phi(z_{\hat{y}}(y^*))} \right]$$

Finally, using $e^{\frac{\sigma_y^2}{2}} = e^{\frac{\sigma_u^2}{2}} e^{\frac{\sigma_y^2}{2}}$ AND $z_{\hat{y}}(y^*) - \sigma_y = z_{\hat{y}}(y^* - \sigma_y^2)$ we have the formula for the selection frontier as shown in equation (13):

$$(13) \quad E[Y | \hat{y} \geq y^*] = \bar{Y} \left[\frac{1 - \Phi(z_{\hat{y}}(y^* - \sigma_y^2))}{1 - \Phi(z_{\hat{y}}(y^*))} \right].$$

3.8 Appendix C – Proof of Existence of a Unique Interior Solution

By our assumptions above, the country's objective function is:

$$(C1) \quad U = aqN - \frac{b}{2}N^2.$$

Where q is the measure of pool quality, N is the number of immigrants admitted and a and b are parameters reflecting taste. The policy frontier which constrains this choice was given by equation (22):

$$(C2) \quad E[Y | p] = \frac{\bar{Y}}{p}(1 - \Phi(\Phi^{-1}(1 - p) - \sigma_{\hat{y}})).$$

We substituting this constraint on the quality measure into (C1) and replacing p with N/T . This transforms our constrained optimization problem in two variables into an unconstrained problem in one – variable, the number of candidates admitted. This specification of the problem is given by.

$$(C3) \quad U(N) = a \frac{\bar{Y}}{N/T} (1 - \Phi(\Phi^{-1}(1 - N/T) - \sigma_{\hat{y}}))N - \frac{b}{2}N^2,$$

$$(C4) \quad = a\bar{Y}T(1 - \Phi(\Phi^{-1}(1 - N/T) - \sigma_{\hat{y}})) - \frac{b}{2}N^2.$$

Since $\Phi^{-1}(x)$ is not defined for $x = 0,1$ the domain of this function is $N \in (0, T)$. We can extend the domain to $N \in (0, T]$ by defining $U(T)$ to be equal to its limiting value i.e.

$U(T) = a\bar{Y}T - \frac{b}{2}T^2$. To show that this problem has a unique interior solution, we will show

that the function is concave and that the first order condition gives rise to a critical point on

$$N \in (0, T]^{27}.$$

To show that it is concave, we must show that the second derivative is always negative.

$$(C6) \quad \frac{dU}{dN} = -a\bar{Y}T\phi(\Phi^{-1}(1-N/T) - \sigma_{\hat{y}}) \frac{-1}{T\phi(\Phi^{-1}(1-N/T))} - bN,$$

$$(C7) \quad = a\bar{Y} \frac{\phi(\Phi^{-1}(1-N/T) - \sigma_{\hat{y}})}{\phi(\Phi^{-1}(1-N/T))} - bN.$$

Substituting in the formula for $\phi(\cdot)$

$$(C8) \quad = a\bar{Y} \frac{1/\sqrt{2\pi}e^{[-(\Phi^{-1}(1-N/T) - \sigma_{\hat{y}})^2/2]}}{1/\sqrt{2\pi}e^{[-(\Phi^{-1}(1-N/T))^2/2]}} - bN,$$

$$(C9) \quad = a\bar{Y} e^{[(-\Phi^{-1}(1-N/T))^2 + 2\Phi^{-1}(1-N/T)\sigma_{\hat{y}} - \sigma_{\hat{y}}^2 + \Phi^{-1}(1-N/T)^2]/2]} - bN.$$

Cancelling the $\Phi^{-1}(1-N/T)^2$ terms we get a simplified version of the first derivative:

$$(C10) \quad \frac{dU}{dN} = a\bar{Y}e^{[\Phi^{-1}(1-N/T)\sigma_{\hat{y}} - \sigma_{\hat{y}}^2/2]} - bN.$$

²⁷ We ignore the issue of continuity in the domain as T , the number of immigrants in the candidate pool will typically be so large as to make N/T an approximately continuous number.

From this, we calculate the second derivative as:

$$(C11) \quad \frac{d^2U}{dN^2} = D_n(\Phi^{-1}(1-N/T)\sigma_{\hat{y}} - \sigma_{\hat{y}}^2/2)a\bar{Y}e^{[\Phi^{-1}(1-N/T)\sigma_{\hat{y}} - \sigma_{\hat{y}}^2/2]} - b,$$

$$(C12) \quad \frac{d^2U}{dN^2} = -\frac{\sigma_{\hat{y}}a\bar{Y}e^{[\Phi^{-1}(1-N/T)\sigma_{\hat{y}} - \sigma_{\hat{y}}^2/2]}}{T\phi(\Phi^{-1}(1-N/T))} - b.$$

Since a , b and T are positive and $e^{[\Phi^{-1}(1-N/T)\sigma_{\hat{y}} - \sigma_{\hat{y}}^2/2]}$ and $\phi(\Phi^{-1}(1-N/T))$ are always greater than 0, the second derivative is negative. As a result, the function is concave.

We still have to show that there is an interior solution to this function. For that we return to the first order condition. Rearranging the (C10) we obtain the first order condition:

$$(C13) \quad a\bar{Y}e^{[\Phi^{-1}(1-N/T)\sigma_{\hat{y}} - \sigma_{\hat{y}}^2/2]} = bN.$$

Since the left hand side of this equation is restricted to non-negative numbers N must be positive for equality to hold. As a result, a positive (though possibly arbitrarily small and non-integer) number of immigrants would be selected. \square

3.9 References

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Chapter 4

Selecting Economic Immigrants: An Actuarial Approach

Abstract

There is growing international interest in a Canadian-style points system for selecting economic immigrants. Although existing points systems have been influenced by the human capital literature, the findings have traditionally been incorporated in an ad hoc way. This paper explores a formal method for designing a points system based on a human capital earnings regression for predicting immigrant economic success. The method is implemented for Canada using the IMDB, a remarkable longitudinal database that combines information on immigrants' characteristics at landing with their subsequent income performance as reported on tax returns. We demonstrate the feasibility of the method by developing an illustrative points system. We also explore how the selection system can be improved by incorporating additional information such as country-of-origin characteristics and intended occupations. We discuss what our findings imply for the debate about the relative merits of points- and employment-based systems for selecting economic immigrants.

4.1 Introduction

There is growing international interest in a Canadian-style points system for selecting economic immigrants.²⁸ At the same time, there is rising concern in Canada about the income performance of recent cohorts of economic immigrants, as many of those selected through the points system struggle in the labour market (Aydemir and Skuterud, 2005; Picot, Hou, and Coulombe, 2007). In this paper, we explore a new approach to the design and evaluation of a points-based selection system. The basic idea is that the system is designed based on the human capital earnings regression that best predicts the earnings of immigrants. We apply this approach to the design of a points system for Canada using the Longitudinal Immigrant Database (IMDB) to develop the prediction model. The IMDB is a remarkable dataset that combines information on the human capital characteristics of immigrants at landing with income data derived from post-landing tax filings, and is uniquely suited to developing our design approach.

The design of the existing points system has undoubtedly been influenced by the vast empirical literature relating immigrant characteristics at landing to their subsequent economic performance. One indication is that the measured human capital—most notably educational attainment—of immigrants admitted under the points system has increased dramatically (see, e.g., Beach, Green, and Worsick, 2006; Picot and Sweetman, 2005). But the design process has followed what can fairly be called a *clinical* rather than an *actuarial* approach: that is, it has

²⁸ Points systems are also used for skills-based selection in Australia and New Zealand. The United Kingdom is in the process of introducing a permanent system to replace its points-based Highly Skilled Migrant Programme that was first introduced on a pilot basis in 2002 (United Kingdom Home Office, 2006). Points systems are under consideration in France, Ireland and Spain. In Germany, a points system went down in a narrow legislative defeat in 2003. A points system was not part of the comprehensive immigration reform passed by the U.S. Senate in May of 2006, although it was the subject of hearings of the Senate Committee on Health, Education, Labor, and Pensions in September (see Beach, 2006).

depended on expert judgment rather than an explicit statistically-based design.²⁹ With the multiple objectives that are weighed in any selection system (economic, fiscal, humanitarian, family reunification, etc.), it is inevitable that judgment is applied in the system's overall design. However, we think an approach that focuses directly on predicted earnings is both appropriate and feasible for the economic immigrant stream, where the objective is selecting high-earning immigrants that will strengthen the economy and fiscal system for the benefit of the pre-immigration population.³⁰

We thus develop an actuarial – or optimal-prediction-based-on-historical-data – approach to the design of the system for selecting economic immigrants. The central idea is to use data on the landing characteristics and subsequent income performance of earlier immigrant cohorts to identify the “best” human capital-based prediction equation. This equation is combined with an explicit threshold for predicted earnings below which applicants are not accepted. The point allocations are then objectively mapped from the parameters of this prediction equation given the

²⁹ The clinical-actuarial distinction is common in psychology, jurisprudence and medicine. A large literature has developed following Meehl (1954) that compares the predictive success of the two methods. The actuarial method has generally found to be superior where the two methods have access to the same information (see, e.g., Dawes, Faust, and Meehl, 1989). Of course, where an expert (i.e. clinician) has access to information unavailable to someone using the statistical model, it is quite possible that the former will make more accurate predictions. For example, a visa officer interviewing an applicant could make a judgment about the individual's social skills and ambition, information that would not be available to the statistical model. However, the use of this type of information is not what is at issue in the design of a system that is dependent on objectively verifiable information. The design problem relates to how best to weigh the various available pieces of information (educational attainment, fluency in official languages, etc.) In this equal-information setting, it is harder to see an advantage for expert judgment over statistical models that are chosen to best fit the historical data.

³⁰ Even from a narrow economic perspective of those already present in the host country, a better measure of economic value is the “surplus” that the country gains from the immigrants. This surplus can be defined as the value the country receives less what they must pay to the immigrants. Simple models show that it is not necessarily the most highly skilled immigrants that generate the greatest surplus (see, e.g., Borjas, 1995). However, the relevance of human capital is likely to increase when we allow for fiscal effects, knowledge spillovers, or the value of specialized skills. Augmenting the relative supply of skilled workers should also reduce overall earnings inequality, so that skilled recruitment can be desirable on both efficiency and equity grounds. But whatever the merits of focusing narrowly on skills, it is the case that a number of countries are striving to select more skilled and higher earning immigrant pools. It is thus worthwhile to look for a more systematic approach to designing a skills-based selection system.

chosen threshold. We also develop the concept of the selection frontier as a means for evaluating selection systems. The frontier shows the tradeoff between the expected earnings of the pool of admitted immigrants and the number admitted, with each point on the frontier mapping to a unique predicted earnings threshold. The position of the frontier will depend on predictive success of the underlying earnings regression, with the best prediction equation leading to the highest feasible frontier.

Although there is growing interest in points systems among industrial countries, there is also a debate about their effectiveness. One view is that the quality of a country's immigrant stream is dominated by the pool of people who desire to move to the country (Jasso and Rosenzweig, 2005). This suggests that fine-tuning the selection system is unlikely to have significant effects. Another view holds that the design of the selection system does have first order effects on immigrant labour market success (see, e.g., Lester and Richardson on the comparison of the Canadian and Australian points systems). The actuarial approach allows us to examine the potential for fine-tuning a conventional points system by adjusting allocations to the usual point sources such as education, experience and language skills. Subject to data availability, this approach also allows us to explore, in a systematic, way the potential contribution of less conventional sources of points that have been suggested by the human-capital literature (country-of-origin, achievement on literacy tests, quality of educational institution, pre-migration earnings, etc.). By exploring the performance of the best designed point systems, the actuarial approach should help inform whether there is a need for more radical departures from points-based selection, such as strict pre-immigration job offer requirements or probationary periods on temporary work visas before permanent immigration status is granted.

The rest of the paper is structured as follows. In the next section, we review the related literature on immigrant assimilation and the effectiveness of selection systems. We then describe

our design methodology in Section 3 and our data in Section 4. Section 5 then develops an illustrative points system and discusses various extensions. Section 6 concludes with a discussion of what our results imply about the effectiveness of even the best designed points system.

4.2 Related Literature

Following Chiswick (1978), a large literature has developed that explores how human capital characteristics at landing affect an immigrant's subsequent labour market success. A major theme in this literature is how more recent immigrant cohorts to the United States compare with earlier cohorts in terms of entry earnings and subsequent earnings growth (e.g. Borjas, 1985; Duleep and Regets, 2002). A substantial parallel literature has developed looking at Canadian immigrants. A central focus has been the declining performance of more recent immigrant cohorts relative to native-born workers (Abbott and Beach, 1993; Baker and Benjamin, 1994; Bloom, Grenier, and Gunderson, 1995; Grant, 1999; Frenette and Morissette, 2003; Green and Worswick, 2004; Aydemir and Skuterud, 2005; Picot, Hou, and Coulombe, 2007). Two important findings have been that immigrants that come at young ages tend to perform better (possibly reflecting the acquisition of Canadian schooling) and that there is a negligible return to foreign experience.³¹ A number of recent studies have looked at how less traditional human capital measures are associated with labour market performance: credential acquisition or "sheepskin effects" (Ferrer and Riddell, 2004); source-country educational quality (Sweetman, 2004); and literacy skills (Ferrer, Green, and Riddell, 2004; Alboim, Finnie, and Meng, 2005).

³¹ See Schaafsma and Sweetman (2001). See also Friedberg (2002) for a similar finding of a low return to foreign experience for immigrants to Israel.

There is also a smaller literature that looks at how alternative immigrant selection systems affect immigrant characteristics and performance. A key issue in this literature is whether immigrant quality is affected more by who desires to emigrate to a particular host country or by the selection system that the host country employs. Jasso and Rosenzweig (1995) find a small difference between the performance of U.S. immigrants screened for skills and those who gain admission based on family ties. More recently, Jasso and Rosenzweig (2005) find little difference in the operation of the employment-based U.S. and the skills-based Australian selection systems, leading them to conclude that the immigrant mix is largely driven by the self-selection decisions of the immigrants. Antecol, Cobb-Clark, and Trejo (2001) find that immigrants to Australia and Canada do have more measured human capital than immigrants to the U.S., but conclude that this has more to do with the latter's geographic and historic ties to Mexico than with differences in selection systems.

For Canada, Beach, Green, and Worswick (2006) have found variations in the Canadian selection system—including variations in the way points are allocated for different measures of human capital—do impact the characteristics of the admitted immigrants. Adyemir (2002) develops and empirically implements a model that allows for both self-selection and host-country selection, and finds that both are important in determining who actually immigrates. In a direct comparison of the Australian and Canadian points-based systems, Lester and Richardson (2004) argue that reforms to the Australian system explain the recent better performance of the Australian economic immigrants (see also Hawthorne, 2005).

It is difficult to sum up these substantial literatures. The immigrant-assimilation literature has certainly demonstrated the usefulness of human capital-based earnings regressions for predicting immigrant success. The selection-system literature shows that when a system selects for given characteristics it does tend to have an immigration flow with those

characteristics, but there is less agreement on how much the selection system can affect the labour market success of the admitted immigrants. As far as we can tell, there has not been a previous attempt to explore the optimal design of the selection system using human capital-based earnings prediction. With the proposed actuarial approach, we hope to identify the optimal selection in a rigorous and transparent way, to explore the scope for fine-tuning a conventional points system to improve immigrant selection, and to contribute to the debate about the merits of points-based selection.

4.3 Optimal Design Methodology

In this section, we summarize the basic steps for identifying the optimal points system. This method builds on the discussion in Chapter 3 to which the reader is referred for additional details. The inputs for this method are a human capital-based earnings regression for making predictions of immigrant labor-market success and a (lifetime) predicted-earnings threshold for deciding who to accept. The outputs are the point allocations per unit of each human capital characteristic.

To illustrate the basic design approach, we assume that an immigrant's earnings depend only on their years of schooling (S_i), years of experience (E_i), and years since migration (t_i).

Host-country earnings are given by a log-linear earnings regression:

$$(1) \quad \ln Y_{it} = y_{it} = \beta_0 + \beta_1 S_i + \beta_2 E_i + \beta_3 t_i + u_{it} \quad u_{it} \sim n(0, \sigma_u^2).$$

We use regression analysis to obtain a predictor of log earnings,

$$(2) \quad \hat{y}_{it} = \hat{\beta}_0 + \hat{\beta}_1 S_i + \hat{\beta}_2 E_i + \hat{\beta}_3 t_i$$

To obtain the log of expected earnings, we need to add $\sigma_u^2 / 2$ to the expectation of log earnings,³²

$$(3) \quad \ln \hat{Y}_{it} \approx \frac{\sigma_u^2}{2} + \hat{y}_{it} = \frac{\sigma_u^2}{2} + \hat{\beta}_0 + \hat{\beta}_1 S_i + \hat{\beta}_2 E_i + \hat{\beta}_3 t_i.$$

Letting T_i represent the number of years that the immigrant will be in the host labour market and letting δ represent the discount rate, we can use (3) to write the present discounted value of predicted earnings as,³³

$$(4) \quad \begin{aligned} \hat{Z}_i &= \int_0^{T_i} e^{-\delta t_i} \hat{Y}_{it} dt_i \\ &= e^{\frac{\sigma_u^2}{2} + \hat{\beta}_0 + \hat{\beta}_1 S_i + \hat{\beta}_2 E_i} \int_0^{T_i} e^{(\hat{\beta}_3 - \delta)t_i} dt_i \\ &= e^{\frac{\sigma_u^2}{2} + \hat{\beta}_0 + \hat{\beta}_1 S_i + \hat{\beta}_2 E_i} \left(\frac{1}{\hat{\beta}_3 - \delta} \right) \left(e^{(\hat{\beta}_3 - \delta)T_i} - 1 \right) \end{aligned}$$

³² The expectation of log earnings is less than the log of expected earnings, see Goldberger (1968).

³³ Assuming that there is no out-migration of emigrants, δ will reflect the rate at which the policy maker discounts future earnings relative to current earnings. However, assuming a constant conditional probability of exit (or “hazard rate”), δ can also conveniently include a discount due to expected attrition due to out-migration.

We assume that the immigrant will work until age \bar{A} , so that $T_i = \bar{A} - A_i$, where A_i is age at landing. Making this substitution and taking logs yields,

$$(5) \quad \ln \hat{Z}_i = \frac{\sigma_i^2}{2} + \hat{\beta}_0 + \hat{\beta}_1 S_i + \hat{\beta}_2 E_i - \ln(\hat{\beta}_3 - \delta) + \ln\left(e^{(\hat{\beta}_3 - \delta)(\bar{A} - A_i)} - 1\right)$$

We next assume that the policy maker sets a threshold, \hat{Z}^* , for predicted lifetime earnings. Any applicant with predicted earnings at or above this level is accepted; others rejected. To obtain the points allocations, we arbitrarily set the point allocation to 100 for someone with predicted earnings that is exactly equal to the threshold. With predicted earnings set equal to the threshold, we can rearrange equation (5) to obtain the per unit points allocation for each of the human capital characteristics.

$$(6) \quad \frac{100\tilde{\beta}}{\tilde{\beta}} = \left(\frac{100\hat{\beta}_1}{\tilde{\beta}}\right)S_i + \left(\frac{100\hat{\beta}_2}{\tilde{\beta}}\right)E_i + \left(\frac{100\ln\left(e^{(\hat{\beta}_3 - \delta)(\bar{A} - A_i)} - 1\right)}{\tilde{\beta}}\right),$$

$$\text{where } \tilde{\beta} = \ln \hat{Z}^* - \frac{\sigma_i^2}{2} - \hat{\beta}_0 + \ln(\hat{\beta}_3 - \delta).$$

The respective point allocations for schooling and experience are given by the relevant terms in parentheses in equation (6). The last term in the equation determines the non-linear point allocations given for age-at-landing. Based on these allocations, any applicant that scores 100 points or above has above-threshold predicted earnings and is accepted.

The performance of this system can be assessed in terms of the selection frontier, which shows the trade-off between the “quality” of the selected immigrants as measured by the expected

future earnings of that pool and the number admitted. As we demonstrated in Chapter 3, the location of the frontier is determined by the explanatory power of the regression, measured by R^2 : the higher the R^2 , the more efficient the selection process and the less binding the selection frontier. Thus, comparisons of R^2 provide some insight into the relative performance of different specifications of the model or allocations of points.

4.4 Data³⁴

The actuarial approach to designing a points system depends on the availability of historical data on both the characteristics of immigrants at landing and their subsequent performance in the labour market. As mentioned above, the Canadian IMDB is an ideal source of both types of data. The IMDB is an administrative database containing information on immigrants to Canada since 1980. It combines static information from an immigrant's landing records with income data from tax filings.³⁵ It is worth noting that this is not a sample of immigrants, but rather the population of immigrants with at least one personal income tax filing. The database is updated annually as new immigrant cohorts arrive and new tax data becomes available. Tax return data is only recorded for the fifteen years after the first tax filing, so that we have at most 15 annual income observations on each immigrant.

In terms of static (or “tombstone”) data on landing characteristics, the IMDB contains basic demographic data (sex, age, country of birth); skill measures (English / French language

³⁴ The information in this section draws heavily on publicly-available documentation of the IMDB provided by Citizenship and Immigration Canada (CIC) and Statistics Canada as well as Abbott (2003) and personal communication with CIC employees.

³⁵ Public access to the IMDB is strictly constrained given the sensitive nature of the underlying tax and personal information. As a consequence, we did not have direct access to the data. We are extremely grateful to Citizenship and Immigration Canada and Statistics Canada for generously agreeing to work with us to implement the required data runs.

ability, native language, years of schooling, educational attainment); intended settlement in Canada (province and city, industry and occupation); family status; and admission details (immigrant category, applicability of points system, allocation of sufficient points for admission, principal applicant flag.) The dynamic data consists of up to 15 years of income data by income type (e.g. employment earnings, investment income, rental income, etc.)

Our interest in this data is principally centered on the economic immigrants as opposed to those admitted under the family class or refugees. We are further interested in separating the impact of earnings from returns to capital, therefore, we exclude immigrants from the investor and entrepreneur classes and use wage and salary earnings as our dependent variable. The selection criteria then are: principal applicants between the ages of 18 and 64 who enter in IMCAT category 7 (skilled workers principal applicant abroad no special program) or IMCAT category 8 (skilled workers principal applicant in Canada or with special program). For this group our dependent variable is the log of total earned income, which is the sum of all reported earnings on the individual's tax records.

The IMDB does have some limitations. First, a number of immigrants to Canada have never filed a tax return and therefore do not appear in the sample. Second, immigrants can be temporarily or permanently absent from the country through return-migration, on-migration to a third country, or death. This results in an unbalanced panel sample. Third, the IMDB does not contain reason-codes for individuals not filing a tax return, thus, that we cannot be sure why an individual has disappeared from the sample.

We have supplemented the IMBD data with aggregate variables for both country-of-destination and country-of origin. Two aggregate Canadian variables were added to control for macroeconomic effects: the national unemployment rate (CANSIM Table 282-0002) and the log of average real annual earnings for full-time, full-year workers (CANSIM Table 202-0101).

Three aggregate country-of-origin variables were included to control for conditions in the source country that might affect the unobserved human capital of immigrants. Since higher cost to emigrate should tend to increase the selection based on unobservable human capital and migration costs rise with distance, we included log of distance from Canada (taken from Andrew Rose's bilateral trade database³⁶). Based on Borjas (1987) we hypothesized that when source-country inequality is high, there is a reduced incentive for highly-skilled individuals to emigrate. To capture the unobservable component, we included the 1980-2004 average of the Gini coefficient³⁷ (World Bank, World Development Indicators). Finally, an immigrant's human capital is likely better suited to the Canadian economy and the educational institutions are likely to be of higher quality if that immigrant comes from a developed country. To capture this, we included, the log of real GDP per capita adjusted for purchasing power parity (World Bank, World Development Indicators). The summary statistics for all variables used in the regressions are shown in Table 4.1.

³⁶ Available at <http://faculty.haas.berkeley.edu/arose/>.

³⁷ The Gini coefficient is only available in household survey years. These years vary from country to country.

Table 4.1 - Summary Statistics

	Obs.	Median	Mean	S.D
<i>Individual Variables</i>				
Log Annual Earnings (constant 2005 Dollars)	314,892	10.44	10.29	0.95
Landing Year	314,892	1991	1991	6.49
Tax Year	314,892	1998	1996	5.97
Age at Landing	314,892	32	33	7.14
Years Since Migration	314,892	5	6	3.80
Years of Schooling	313,631	15	14	3.83
Experience	313,631	12	14	7.70
English Language (mother tongue)	314,892	0	0.21	0.41
French Language (mother tongue)	314,892	0	0.05	0.21
Primary	314,892	0	0.09	0.28
Secondary	314,892	0	0.14	0.34
Some Post-Secondary	314,892	0	0.07	0.26
Trade Certificate	314,892	0	0.14	0.34
Diploma	314,892	0	0.11	0.31
Bachelors	314,892	0	0.32	0.47
Masters	314,892	0	0.10	0.29
PhD	314,892	0	0.04	0.19
<i>Macro Variables</i>				
Unemployment Rate	314,892	0.078	0.086	0.01
Log Average Annual Earnings (constant dollars)	314,892	10.75	10.73	0.04
<i>Country-of-Origin Variables</i>				
Log GDP-Per-Capita	284,866	8.36	8.62	1.01
Log Distance (from Canada)	299,074	8.66	8.52	0.36
Gini	279,736	39.33	39.77	7.30

Sample includes Skilled Workers, Principal Applicants (IMCAT categories 7 & 8) with earnings > \$1,000

4.5 Empirical Implementation

4.5.1 Base Regression

To determine the feasibility of the proposed design approach, we first demonstrate the development of a simple points system that is linear in experience, language ability and educational attainment, and non-linear in age-at-landing. The base regression from which this illustrative points system is derived is shown in Table 4.2. We record two specifications, the first

with and the second without an age-at-landing variable.³⁸ We also record two estimation methods for each specification: ordinary least squares (with standard errors that are robust to individual immigrant-level clustering); and random effects to explicitly take account of serial correlation in individual earnings over time.³⁹

The dependent variable is the log of real annual earnings expressed in constant 2005 dollars. We impose the additional restriction that annual earnings are greater than \$1,000. We do not include earnings observations for the year of landing, since the length of time will typically be less than a full year and will vary across immigrants. Experience is defined as Age-at-Landing – Years of Schooling – 5. Language enters as a pair of dummy variables: an English dummy that takes the value 1 if English is the immigrant’s native language; and a French dummy that takes the value 1 if French is the native language. Educational attainment enters as a set of seven dummy variables (with Primary the excluded category): Secondary, Some Post-Secondary, Trade Certificate, Diploma, Bachelors, Masters, and PhD. We also include a full set of cohort year dummies for the years 1981 to 2003 (with 1980 chosen as the excluded cohort).⁴⁰ We include two variables to control for macro/time effects: the national unemployment rate to

³⁸ Recall that age-at-landing still matters for points even if an age-at-landing variable is not included in the regression. The reason is that age-at-landing determines potential years in the Canadian labour market. Although age-at-landing is likely to affect an immigrant’s capacity to adapt to the Canadian labour market, we are concerned about our ability to separately identify the age-at-landing and experience effects. This stems from our relatively crude measure of experience: Age-at-Landing – Years of Schooling – 5. Controlling for age-at-landing, the experience effect is then identified by variation in years of schooling (holding educational attainment constant), which we think is a weak basis for identification. Thus, we concentrate on the results without the age-at-landing variable in developing the illustrative points system.

³⁹ We use random effects rather than fixed effects for two reasons. First, under fixed effects, the coefficients on all linear time-invariant explanatory variables cannot be estimated. In our regressions, most of the central variables of interest take this form. And second, given that our interest is in predicting earnings, we are not concerned about correlation between the explanatory variables and the error term (a problem that fixed effects can help fix). Provided that these correlations are stable over time—e.g. high educational attainment is stably correlated with unobserved natural abilities that positively affect earnings—it is advantageous for earnings predictions to be able to use observed human capital characteristics as indicators of unobserved abilities. Thus we do not present our estimated coefficients as estimates of the returns to human capital, but rather as associations in the historic data.

⁴⁰ There is no 2004 cohort since we include earnings observations only on the first full year after year of landing.

control for business cycle effects and trend movements in the underlying structural rate of unemployment; and the log of real annual earnings for full-time, full-year workers to control for secular trends in economy-wide earnings.⁴¹

⁴¹ The separation of cohort, years-since-migration and macro effects has been a major focus of the empirical literature on immigrant earnings. Since our data from the IMBD is for immigrants only, we could not utilize the common identification practice of assuming that macro effects are equal for immigrants and natives. We did explore the method originated independently by Hall (1971) and Mason et al. (1973) of including a full set of both cohort and time dummies (in addition to the year-since-migration variable), and imposing the identification constraint that either two of the cohort dummies or two of the time dummies have equal coefficients. As is well-described by Glenn (2005), the results can be highly sensitive to the chosen identification constraint. Some experimentation with alternative conditions showed this to be the case with our data. Thus, lacking a priori grounds for choosing a restriction, we decided against this approach. We caution, however, that the type of cohort, years-since-migration, macro decomposition we are seeking is unavoidably problematic, and additional studies are needed to confirm the robustness of our results.

**Table 4.2 - Basic Log Earnings Regressions
Skilled Workers, Principal Applicants**

Dependent Variable = Log Annual Earnings

	(1)		(2)	
	OLS	Random Effects	OLS	Random Effects
Age at Landing	...	...	0.0201 *	0.0170 *
			(0.0020)	(0.0021)
Years Since Migration	0.0202 *	0.0142 *	0.0202 *	0.0142 *
	(0.0009)	(0.0006)	(0.0009)	(0.0006)
Experience	-0.0013 **	-0.0023 *	-0.0203 *	-0.0184 *
	(0.0005)	(0.0005)	(0.0019)	(0.0021)
English Language	0.4366 *	0.5268 *	0.4292 *	0.5197 *
	(0.0094)	(0.0105)	(0.0094)	(0.0105)
French Language	0.0621 *	0.1403 *	0.0655 *	0.1422 *
	(0.0165)	(0.0174)	(0.0164)	(0.0174)
Secondary	-0.0026	0.0009	-0.0837	-0.0666 *
	(0.0154)	(0.0120)	(0.0172)	(0.0216)
Some Post-Secondary	0.2331 *	0.2150 *	0.0858 *	0.0910 *
	(0.0189)	(0.0223)	(0.0236)	(0.0270)
Trade Certificate	0.2421 *	0.2212 *	0.1319 *	0.1276 *
	(0.0161)	(0.0202)	(0.0192)	(0.0232)
Diploma	0.3315 *	0.3161 *	0.1862 *	0.1940 *
	(0.0170)	(0.0208)	(0.0219)	(0.0257)
Bachelors	0.5291 *	0.5037 *	0.3463 *	0.3515 *
	(0.0154)	(0.0188)	(0.0232)	(0.0266)
Masters	0.6383 *	0.5846 *	0.4188 *	0.4020 *
	(0.0182)	(0.0209)	(0.0279)	(0.0380)
PhD	0.9294 *	0.8862 *	0.6602 *	0.6606 *
	(0.0218)	(0.0259)	(0.0340)	(0.0380)
Unemployment Rate	-3.3675 *	-3.8351 *	-3.3743 *	-3.8357 *
	(0.1500)	(0.1067)	(0.1500)	(0.1067)
Log Average Annual Earnings	2.2447 *	2.6093 *	2.2454 *	2.6095 *
	(0.1129)	(0.0832)	(0.1129)	(0.0832)
Constant	-13.7058 *	-17.6144	-13.9653 *	-17.8306 *
	(1.2046)	(.8896)	(1.2048)	(0.8900)
Cohort Year Dummies	Yes	Yes	Yes	Yes
R Squared	0.1410	0.1386	0.1423	0.1400
Within	...	0.0607	...	0.0607
Between	...	0.1352	...	0.1362
Root Mean Square Error	0.8770	...	0.0876	...
Observations	313,631	313,631	313,631	313,631
Individuals	50,610	50,610	50,610	50,610

Standard errors are in parentheses; OLS standard errors are robust to individual-level clustering.

* = significance at 1% level; ** = significance at 5% level.

Sample includes Skilled Workers, Principal Applicants (IMCAT categories 7 & 8) with annual earnings > \$1,000

An obvious concern with our design approach is that the immigrant earnings generation process might not be stable over time. One reason to worry about instability is that past

immigrants are obviously a selected sample, and the nature of that selection may change over time. We have tried to minimize the instability in two ways. First, we have limited our sample to immigrants who enter as principal applicants in the skilled worker stream. Since these individuals have been selected through the points system, they have been selected based on observed human capital characteristics. With selection on observables, even the fact that our historic sample is in an obvious way a “selected sample” should not lead to a bias that is sensitive to the precise nature of the selection process. Second, although the composition of the immigrant pool has certainly been changing over time (most obviously in the country-of-origin distribution of the admitted immigrants), we can crudely capture the changing distribution with cohort dummies. We can then use the regression model that applies to the most recent available cohort for projecting forward (or even take account of trends in the cohort effects).⁴²

The estimated human capital equation appears to perform well, with results that are broadly consistent with the existing literature. Focusing on Regression (1), we find a small negative effect of foreign experience. The coefficient on the years-since-migration variable shows that immigrant earnings grow at a real rate of roughly 2 percent per-year post-landing (after controlling for average economy-wide earnings). On language, we find that English is substantially more highly rewarded than French (approximately a 44 percent premium versus a 6 percent premium), no doubt reflecting the fact that a substantial majority of admitted immigrants move to English-speaking Canada.⁴³ The educational attainment variables broadly show the

⁴² Using just cohort dummies assumes that the coefficients on the human capital characteristics are stable over time. This assumption can be tested and, if necessary, relaxed using cohort-human capital variable interactions.

⁴³ An interesting extension would be to include interactions between the language variables and intended province of destination. This would, for example, allow us to explore the value of French for immigrants intending to reside in Quebec.

expected pattern, with the anomaly that Secondary shows slightly lower returns than Primary.⁴⁴ Interestingly, immigrants with a trade certificate have roughly equal earnings to those with some post-secondary attainment. The results show substantial earnings premiums are associated with higher educational attainment. Compared to the base category, the premium for a bachelor's degree is approximately 19 percent higher than that for a diploma; a Master's degree has a premium that is approximately 11 percent higher than that for bachelors; and a PhD has a premium that is approximately 29 percent higher than that for Masters. The macro variables have the expected signs. Most notably, the coefficient on the economy-wide average earnings variable is quantitatively large, with a 1 percent increase in economy-wide earnings associated with a 2.2 percent increase in immigrant earnings.⁴⁵

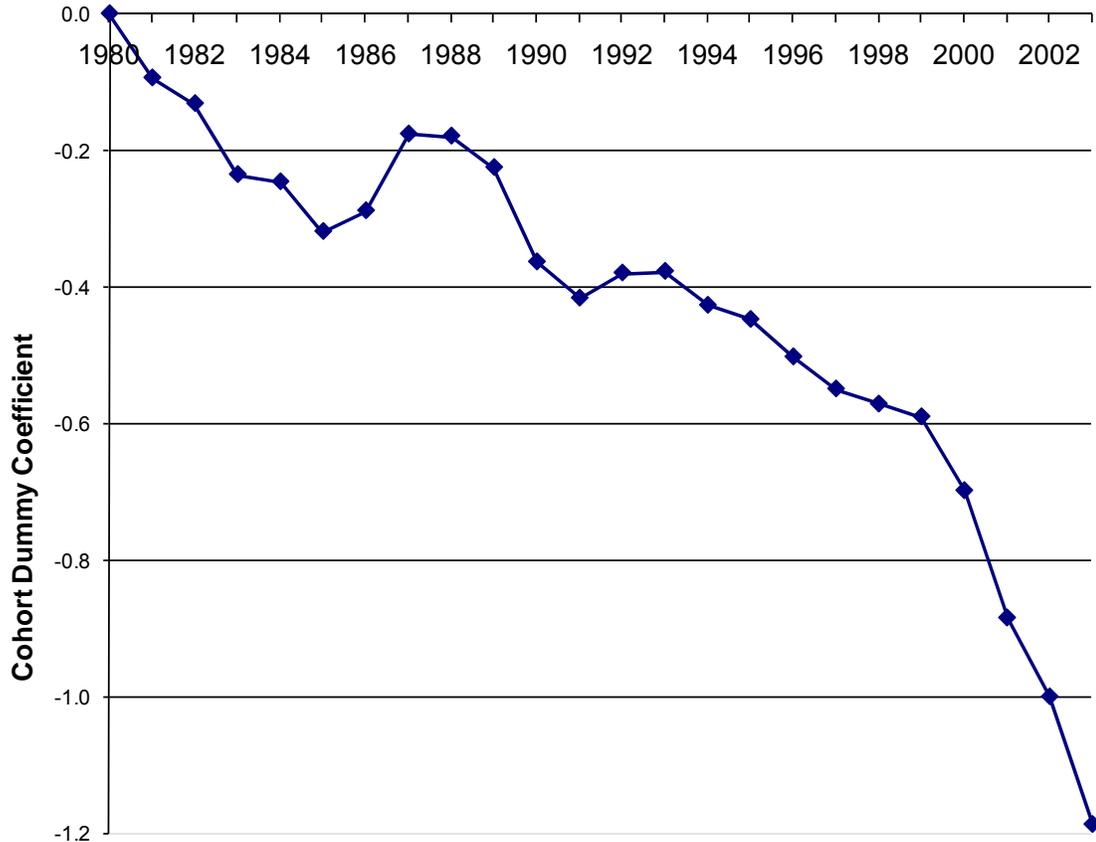
Figure 4.1 displays the cohort effects (with the excluded cohort, 1980, equal to zero). The pattern of deteriorating cohort earnings holding human capital constant is consistent with previous findings—but the extent of the deterioration is dramatic.

Overall the regression explains just over 14 percent of the variation in log earnings. While this is broadly in line with the vast literature on human capital-based earnings regressions, it is an undeniably low number, suggesting that immigrant earnings performance is dominated by idiosyncratic factors. This in turn suggests fundamental limits to the points-based selection approach. In Section 4.5.3 we explore how the predictive power of the regression might be improved by adding additional observables. First, however, we show how a simple quasi-linear points system can be developed based on an illustrative regression.

⁴⁴The difference is not statistically significant in our base regression. The coefficient on Secondary becomes positive and statistically significant when we include all streams in the sample.

⁴⁵ It is worth noting that this was a period of relatively low growth in economy-wide average earnings (just 0.5 percent over 1980 to 2004). Thus even with the high sensitivity to economy-wide earnings, there was still relatively low macro-related trend growth in immigrant earnings (approximately 1.1 percent).

Figure 4.1 - Estimated Cohort Year Effects (1980 = 0), 1980 - 2003



4.5.2 An Illustrative Points System

The points system that is implied by Regression (1, OLS) is shown below in Table 4.3. For this illustration, we assume that the discounted lifetime earnings threshold is set at \$1,500,000 in constant 2004 dollars and the discount rate is set at 0.02. As described in Section 3, any applicant with a combination of characteristics that yields 100 points or more will be accepted (since 100 points or more means that lifetime predicted earnings are at least \$1,500,000). The underlying regression is somewhat more complicated than the simple example in Section 3, as it includes both cohort and macro effects in addition to measures of human capital

at landing. Making the assumption that the most recent available estimated cohort effect (i.e. for 2003) provides the best indicator of future cohort effects, we add this to the regression constant to determine the constant for prediction equation for log earnings that underlies the points system. For the macro effects, we set the log of average earnings at its 2005 level (\$47,800) and assume trend growth in earnings equal to the Bank of Canada's estimate for the underlying productivity growth rate (1.5 percent, Bank of Canada, 2006). We also assume that the unemployment rate is constant at its 2005 level (6.8 percent).

These additional variables require changes to the points allocation equations developed above. Equation (1) becomes:

$$(1') \quad \ln Y_{it} = y_{it} = \beta_0 + \beta_H H_i + dD_i + \beta_3 t_i + \beta_4 \bar{y}_t + u_{it} \quad u_{it} \sim n(0, \sigma_u^2).$$

In this version, years of schooling, S_i and years of experience at landing, E_i are replaced by H_i , a vector of all time-invariant characteristics⁴⁶ to which points could be allocated. In addition to human capital characteristics, H can include other variables that are not normally thought of as human capital such as source country GDP per capita. D is introduced as a vector of dummy variables (e.g. cohort dummies) and economic characteristics (e.g. unemployment rate at landing) to which points will not be allocated. Finally, \bar{y}_t is the log of average earnings for full-time Canadian workers.

Using this specification and following the steps above, a revised $\tilde{\beta}$ can be calculated as:

$$(6') \quad \tilde{\beta} = \ln \hat{Z}_i - \frac{\sigma_u^2}{2} - \hat{\beta}_0 - \hat{d}D + \ln(\hat{\beta}_3 + \hat{\beta}_4 \bar{y}_0 g - \delta),$$

Where \bar{y} is the last available log of average earnings for full-time Canadian workers and g is its forecasted growth rate.

⁴⁶ The values of these characteristics are all fixed at the time of landing.

Table 4.3 - Illustrative Points System

Points threshold = 100; Points allocations based on Regression 1 (OLS), Table 4.2

Experience (per year)	-0.1		
Language			
English	32.7		
French	4.7		
Educational Attainment			
Secondary	-0.2		
Some Post-Second	17.5		
Trade Certificate	18.1		
Diploma	24.8		
Bachelors	39.6		
Masters	47.4		
PhD	69.6		
Age at Landing			Age at Landing (Continued)
63	-252.4	40	16.8
62	-199.2	39	21.3
61	-167.5	38	25.7
60	-144.7	37	30.0
59	-126.7	36	34.2
58	-111.7	35	38.3
57	-98.9	34	42.3
56	-87.5	33	46.2
55	-77.4	32	50.1
54	-68.2	31	53.9
53	-59.7	30	57.6
52	-51.8	29	61.3
51	-44.5	28	64.9
50	-37.5	27	68.5
49	-31.0	26	72.0
48	-24.8	25	75.5
47	-18.9	24	78.9
46	-13.2	23	82.3
45	-7.8	22	85.7
44	-2.5	21	89.0
43	2.6	20	92.3
42	7.5	19	95.6
41	12.2	18	98.8

Calculated Beta-Tilda 0.0133451

Assumptions:

1. Lifetime earnings threshold (constant 2004 dollars) 1,500,000
2. Assumed trend growth in average annual earnings 1.50%
3. Average Earnings in 2003 (full year, full time) 48,700
4. Unemployment rate in 2003 6.8%
5. Discount rate (δ) 0.02

There are a number of notable features of the resulting point allocations. First, rather than being a source of points, experience at landing actually attracts a small points penalty. Second, points for English exceed points for French by a factor of more than six. Third, while the highest point allocations are granted to those with higher educational attainment, the holders of trade certificates also receive substantial points (comparable to someone with some post-secondary education). And fourth, and perhaps most surprisingly, age-at-landing has a dramatic impact on points. In our illustrative system, it is practically impossible for someone older than their mid-forties to meet the points threshold; on the other hand, it is hard for someone younger than their mid-twenties not to meet the threshold. The strong influence of age follows from the aggregation of lifetime earnings over potential years in the Canadian labour market (64 – Age-at-Landing). However, the relative impact of the age-at-landing variable can be attenuated by using a higher discount rate (matched by an appropriately lowered threshold), which effectively reduces the weight given to later years worked in Canada.

It is useful to examine a couple of examples to get a better feel for when someone succeeds or fails to make the threshold in this illustrative system. For our first example, we take a 37-year-old native English speaker with a Master's degree and 12 years of experience.⁴⁷ The projected lifetime earnings of this individual is \$1,700,082. Using an appropriately extended version of Equation (4), this projection can usefully be decomposed into the product of initial earnings of \$38,529 and multiplied by 44.124 – a factor we refer to as the “adjusted potential years.” The adjusted potential years reflects the potential years in Canada adjusted by the coefficient on the years since migration variable, the discount rate, and the product of the coefficient on the log of average annual earnings variable and the assumed growth rate for these earnings. The point allocations for this applicant are -1.1 for experience, 32.7 for language, 47.8

⁴⁷ We assume they apply in 2005.

for educational attainment and 30.0 for age, for a total of 109.4 points. This applicant has more than 100 points and would, therefore, be accepted. For our second example, we take a 25-year-old native French speaker with a trade certificate and 5 years of experience. Initial projected earnings are \$17,985 and adjusted potential years are 81.02, for total projected earnings of \$1,487,065. This individual falls just below the projected earnings cutoff. Consistent with the earnings shortfall there is also a points shortfall: -0.5 for experience, 4.7 for language, 18.1 for educational attainment and 75.5 for age, for a total of 97.8. An applicant with this profile would be rejected. However, if this individual was just one year younger with correspondingly one year less experience they would score 101.4 points (with projected lifetime earnings of \$1,527,402) and would be accepted.

Even though this points system is just meant as an illustration, it is interesting to compare it with Canada's existing points allocation. The clearest picture comes from comparing the relative points given for various pairs of characteristics rather than the absolute allocations of points. Most strikingly, under the present grid, 25 out of a maximum of 100 points are available for experience, while our findings suggest that no – or even slightly negative points – should be allocated for experience. For education, the same points (25) are allocated for a PhD as a Masters degree, which is not far above the points given for a two-year university degree (20). In contrast, our findings identify a much steeper educational attainment-points gradient. On age, the current grid calls for the maximum of age-related points to be given for applicants between 21 and 49 (10), with two-points per year penalties for each year above or below this range. Our findings identify both a larger relative weighting on age in general, and monotonically falling points with the actual age at landing. Because it is not limited to variables that are available in the IMDB, the current points system has the advantage of access to certain information not available to us. This information includes the presence of arranged employment, spouse's educational attainment,

years of post-secondary study in Canada, and family relationships in Canada. However, these data could be collected in an expanded IMDB. We return to the benefits of expanding the range of individual data that is collected in the concluding comments below.

4.5.3 Extended Regressions

Taking the IMDB as given, we next explore how enriching the informational base for which points are given can lead to a better performing immigrant pool. Based on the Selection Frontier developed in Chapter 3, we use the R^2 from the earnings regression as our measure of the predictive success of the selection system. We explore the addition of three types of information: non-linear terms for the foreign experience and years-since-migration variables; country-of-origin information; and intended-occupation dummies. To ensure valid comparisons, we limit our sample to observations for which all three forms of additional information are available. This causes the number of observations to drop from 313,631 to 258,175, and the number of immigrants to drop from 50,160 to 43,218.

The results are recorded in Table 4.4. The first regression is our base regression (without the age-at-landing variable) estimated on the restricted sample. The results are very similar to those for the unrestricted sample. The next three regressions separately add the non-linear terms, the country-of-origin variables and the intended-occupation dummies to the base regression. The

final regression adds all three forms of additional information simultaneously.

Table 4.4 - Extended OLS Regressions: Skilled Workers, Principal Applicants
Non-linearities, Country of Origin, Intended Occupations

<i>Dependent Variable = Log Annual Earnings</i>					
	(1)	(2)	(3)	(4)	(5)
Years Since Migration	0.0183 *	0.0763 *	0.0190 *	0.0191 *	0.0784 *
	(0.0010)	(0.0020)	(0.0010)	(0.0010)	(0.0019)
Years Since Migration Squared	...	-0.0040 *	...	...	-0.0041 *
		(0.0001)			(0.0001)
Experience	-0.0018 *	0.0044 *	-0.0013 *	-0.0042 *	-0.0006 *
	(0.0006)	(0.0016)	(0.0010)	(0.0005)	(0.0016)
Experience Squared	...	-0.0002 *	...	...	-0.0001 *
		(0.0000)			(0.0000)
English Language	0.4774 *	0.4805 *	0.4242 *	0.4418 *	0.4166 *
	(0.0106)	(0.0106)	(0.0118)	(0.0101)	(0.0112)
French Language	0.0525 *	0.0587 *	-0.0654 *	0.0987 *	0.0222
	(0.0177)	(0.0178)	(0.0185)	(0.0173)	(0.0181)
Secondary	-0.0009	-0.0066	-0.0275	0.0212	-0.0067
	(0.0181)	(0.0181)	(0.0174)	(0.0171)	(0.0170)
Some Post-Secondary	0.2700 *	0.2637 *	0.2378 *	0.2081 *	0.1863 *
	(0.0218)	(0.0218)	(0.0213)	(0.0210)	(0.0209)
Trade Certificate	0.2523 *	0.2437 *	0.1855 *	0.1623 *	0.1184 *
	(0.0188)	(0.0187)	(0.0182)	(0.0178)	(0.0175)
Diploma	0.3610 *	0.3532 *	0.3051 *	0.2433 *	0.2101 *
	(0.0197)	(0.0198)	(0.0192)	(0.0195)	(0.0194)
Bachelors	0.5395 *	0.5326 *	0.5029 *	0.3526 *	0.3376 *
	(0.0179)	(0.0180)	(0.0174)	(0.0186)	(0.0185)
Masters	0.6469 *	0.6418 *	0.6298 *	0.4394 *	0.4412 *
	(0.0206)	(0.0206)	(0.0201)	(0.0126)	(0.0215)
PhD	0.9345 *	0.9295 *	0.9067 *	0.7185 *	0.7142 *
	(0.0239)	(0.0239)	(0.0233)	(0.0258)	(0.0255)
Unemployment Rate	-3.0114 *	-2.7417 *	-3.0245 *	-3.0247 *	-2.7636 *
	(0.1677)	(0.1673)	(0.1667)	(0.1648)	(0.1641)
Log Average Annual Earnings	2.4380 *	2.3702 *	2.3806 *	2.4184 *	2.3143 *
	(0.1238)	(0.1231)	(0.1236)	(0.1221)	(0.1213)
Log GDP Per Capita	....	...	0.0971 *	...	0.0782 *
			(0.0048)		(0.0047)
Log Distance	....	...	0.1103 *	...	0.1018 *
			(0.0146)		(0.0141)
Gini	....	...	-0.0083 *	...	-0.0062 *
			(0.0005)		(0.0005)
Cohort Dummies	Yes	Yes	Yes	Yes	Yes
Occupational Dummies	No	No	No	Yes	Yes
R Squared	0.1501	0.1541	0.1631	0.1936	0.2040
Root MSE	0.8768	0.8748	0.8708	0.8542	0.8487
Observations	258,175	258,175	258,175	258,175	258,175
Immigrants	43,218	43,218	43,218	43,218	43,218

Standard errors are in parentheses; OLS standard errors are robust to individual-level clustering.

* = significance at 1% level; ** = significance at 5% level.

Sample includes Skilled Workers, Principal Applicants (IMCAT categories 7 & 8) with annual earnings > \$1,000

Regression (2) shows the effects of adding squared terms for experience and years since migration. The negative coefficient on experience squared shows that the proportionate earnings penalty on foreign experience rises, *cet. par.*, with the extent of foreign experience. The coefficient on years since migration squared is also negative, indicating the growth rate of earnings tends to decline, *cet. par.*, with years in Canada. Indeed, on average earnings peak after just over 19 years. Overall, however, adding these squared terms adds minimally to the explanatory power of the regression, with the R^2 rising slightly from 0.1501 to 0.1541. Of course, adding two quadratic terms to the regression does not exhaust the potential for non-linearities. In particular, it would be worthwhile to explore the explanatory power that comes from adding additional polynomial terms and interaction effects.

Regression (3) shows the effects of adding three country-of-origin variables: the log of real GDP per capita (adjusted for purchasing power parity); the log of distance from Canada, and the Gini coefficient (as a measure of source-country inequality). We hypothesized that the coefficient on the GDP per capita variable would be positive. Our results support this hypothesis, with a 100 percent increase in source country GDP per capita resulting in a roughly 10 percent increase in earnings. We next hypothesized that an increase in the distance of the source-country from Canada would be positively associated with immigrant earnings. This hypothesis also receives support, with a 100 percent increase in distance leading to approximately an 11 percent increase in earnings. Finally, we hypothesized that an increase in source-country inequality will tend to reduce immigrant earnings. Once again, the hypothesis receives support, with a 10 point increase in the Gini coefficient being associated with an approximately 0.8 percent decrease in immigrant earnings. All told, the addition of the three country-of-origin variables only marginally increases the explanatory power of the regression, with the R^2 rising from 0.1501 to 0.1631.

Regression (4) shows the effects of introducing dummies for intended occupation. A dummy variable is introduced for each 2-digit National Occupation Classification (NOC) code with a number of additional classifications introduced by CIC. The introduction of the occupational dummies does lead to a more substantial improvement in the fit of the regression, with the R^2 rising from 0.1501 to 0.1936. It is worth emphasizing that this way of introducing occupation-specific information is quite different from the occupation-shortage approach that is, for example, an important aspect of the Australian points system. Under the latter approach, extra points are granted if there is deemed to be a shortage in the particular occupation. In contrast, our approach looks backwards to the earnings success of past immigrants destined for particular occupations. This has the disadvantage of looking at past rather than present conditions in given occupations, but it has the advantage of focusing on how immigrants have actually done when destined for those occupations rather than economically dubious measures of shortage.⁴⁸ For example, there may be real shortages in certain health-related professions, but immigrants may face challenges in utilizing their human capital in those occupations because of difficulties getting their credentials recognized. Our approach has the merit of recognizing the de facto challenges in given occupations; although one could reasonably question the fairness of punishing future applicants because of inefficient credential recognition in the past.

Table 4.5 records the occupation effects (measured in log points), which are ordered by size of effect. The omitted category is the CIC category of “new worker” (NOCD9914). A small number of the CIC categories did not contain any observations in our sample and are not listed in the table. The first column of the table records the share of our sample destined for the occupation. Clearly, some of the shares are quite small, so that the estimated effects should be treated with some caution. However, the pattern of effects looks largely plausible, with

⁴⁸ Often it seems that the term “shortage” is used where there is upward pressure on wages.

immigrants intending to enter senior management earning the largest premium over new workers, while those intending to be homemakers earning the lowest. By far the largest category is NOCD21 “professional occupations in natural and applied sciences,” with almost a quarter of the sample. Workers intending to enter this occupational category earn a premium over new workers of approximately 50 percent.

Regression (5) finally adds all three forms of information in a single regression. Overall, the fit of the regression increases by more than one-third. But the percentage of variation in log earnings explained is still low at just over 20 percent. While we obviously have not exhausted the types of information that could be used in the underlying prediction regression, the evident difficulty of predicting who will succeed economically based on observed human capital characteristics at landing leads one to ask if there is a better way to select economic immigrants. We take up this question in the concluding section.

Table 4.5 - Estimates of Occupation Effects
Based on Regression (4), Table 4

	Share	Coefficient	Stand. Error
Omitted Occupational Category, NOCD9914, New worker (CIC)	6.04%	0	....
NOCD			
00 Senior management occupations	0.37%	1.2364	0.0814
02 Middle and other management occupations	0.26%	0.9628	0.077
09 Middle and other management occupations	0.46%	0.6797	0.0712
08 Middle and other management occupations	0.08%	0.6221	0.1628
01 Middle and other management occupations	1.18%	0.5535	0.0405
92 Processing, manufacturing and utilities supervisors and skilled oper.	0.23%	0.5198	0.0719
21 Professional occupations in natural and applied sciences	23.52%	0.4911	0.0176
9990 Software pilot (CIC)	0.00%	0.4769	0.3114
72 Trades and skilled transport and equipment operators	5.88%	0.4525	0.0198
07 Middle and other management occupations	0.37%	0.4368	0.0575
11 Professional occupations in business and finance	4.26%	0.4165	0.0222
22 Technical occupations related to natural and applied sciences	7.02%	0.3833	0.0195
31 Professional occupations in health	3.17%	0.3356	0.0252
95 Processing and manufacturing machine operators and assemblers	0.86%	0.3339	0.0369
65 Other Services Manager	0.04%	0.3279	0.1421
73 Trades and skilled transport and equipment operators	6.05%	0.3125	0.0197
04 Middle and other management occupations	0.01%	0.301	0.3023
03 Middle and other management occupations	0.10%	0.2935	0.1773
05 Middle and other management occupations	0.24%	0.2922	0.0912
06 Middle and other management occupations	2.16%	0.2388	0.031
41 Prof. occs in social science, education, gov. services and religion	4.55%	0.2372	0.0228
96 Labourers in processing, manufacturing and utilities	0.63%	0.2006	0.0435
32 Technical and skilled occupations in health	1.36%	0.1786	0.0294
74 Intermediate occs in trans., equip. operation, install. and main.	0.68%	0.1782	0.0458
76 Trades helpers, construction labourers and related occupations	0.73%	0.165	0.0375
94 Processing and manufacturing machine operators and assemblers	1.73%	0.1443	0.0277
9999 Open employment authorization (CIC)	0.02%	0.1302	0.1906
82 Skilled occupations in primary industry	0.34%	0.129	0.0684
62 Skilled sales and service occupations	5.94%	0.0824	0.0194
12 Skilled administrative and business occupations	7.06%	0.0813	0.0188
84 Intermediate occupations in primary industry	0.82%	0.0721	0.0355
34 Assisting occupations in support of health services	0.28%	0.048	0.0669
14 Clerical occupations	2.46%	0.0444	0.0244
52 Technical and skilled occupations in art, culture, and recreation	1.12%	0.0094	0.0342
64 Intermediate sales and services occupations	4.29%	-0.0068	0.2141
42 Paraprofessional occs in law, social services, education and religion	0.50%	-0.0219	0.0425
9911 Student (CIC)	1.31%	-0.0722	0.0335
51 Professional occupations in art and culture	1.47%	-0.1043	0.0326
66 Elemental sales and service occupations	2.02%	-0.1756	0.0249
9992 Retired (CIC)	0.04%	-0.3035	0.1829
9980 Other non-worker (CIC)	0.07%	-0.3679	0.1242
9970 Homemaker (CIC)	0.26%	-0.4477	0.07

Occupations are ordered by size of occupation effect.
Occupational codes were supplied by CIC; they include aggregated NOC codes plus special CIC categories.
Occupational categories without observations in our sample are not listed.

4.6 Concluding Comments

Is there a better way to select economic immigrants? The limited predictive power of the models we have explored certainly motivates a search for alternatives. A leading contender is U.S.-style employer-driven selection. Employers are obviously motivated to work hard to identify talented individuals. They can also utilize a richer informational base: Where did they get their education? How well do they speak the language? How likely is it that their recommenders value their reputations for honest evaluations? Put simply, employers are well-placed to be “experts” when it comes to predicting who will be successful on the job. While granting that employers often have information that cannot easily be integrated into a points system, it is important to recognize that there is a vast literature on the superiority of actuarial/statistical-based over clinical/expert-based judgment across a range of settings (see Grove et al., 2000, for a meta-analysis).⁴⁹ This edge is often present even when the clinician has information that is not available for the statistical analysis (Grove and Meehl, 1996). The typical, and for many surprising, superiority of the actuarial approach stems from a combination of its edge in solving the complex problem of appropriately weighting disparate pieces of information and its avoidance of biases that afflict subjective judgment.⁵⁰

Our prediction, for what it is worth, is that employer evaluations will have a critical role to play. But the most effective feasible selection system is likely to be one that integrates the

⁴⁹ Paul Meehl, a pioneer in the making of these comparisons, sums up the literature as follows: There is no controversy in social science which shows such a large body of qualitatively diverse studies coming out so uniformly in the same direction as this one. When you are pushing over 100 investigations, predicting everything from the outcome of football games to the diagnosis of liver disease, and when you can hardly come up with a half dozen studies showing even a weak tendency in favor of the clinician, it is time to draw a practical conclusion (Quoted in, Ayres, 2007, p. 127).

⁵⁰ See Ayres (2007, Chapter 5) for an accessible recent discussion.

informational value of employer assessments into actuarial-based predictions. The evidence from other areas suggests that this should be done, not by allowing employers to selectively override the points system, but by turning the employer information into a source of points. This could be done, for example, by giving points based on the existence of job offers, salary offers, past home-country salaries, and so on.

The Australian experience also suggests that better selections can be made by improving the informational quality of the type of variables that are currently used: better language ability testing through formal language tests; or better measures of educational attainment by making use of objective rankings of educational institutions. Since the actuarial method looks backwards to determine the optimal weights to place on the various pieces of predictive information, it is important to begin collecting the more fine-grained information as soon as possible. For the IMBD, this means adding new variables to the “tombstone data” part of the database. This additional data could be collected on a random sample of admitted immigrants until it has proven its value for prediction. Notwithstanding the challenges of predicting immigrant success, if the policy objective is to bring in individuals who will succeed economically, an actuarially-based selection system operating on an appropriately rich informational base will be hard to trump.

4.7 References

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