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International migration and occupational licensing: an empirical exploration

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Occupational licensing has been found to inhibit the geographical mobility of professionals. Previous studies in this area have used data on interstate mobility of professionals in the United States. This work reconsiders occupational licensing in the context of international migration rules. This relationship is relevant under the discussions on the Movement of Natural Persons in the General Agreement on Trade in Services. A conditional logit model and a nested logit model are used to study the relationship between the two types of regulation. The results verify the greater importance of immigration rules over occupational licensing in determining the probability of choosing a destination country for potential foreign providers of engineering services.

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1. Introduction

The anti-competitive effect of occupational licensing in the professions was empirically tested by Benham [1980] and Kleiner and Kudrle [2000]. These studies have shown that members of self-regulating professional associations are able to extract economic rents by establishing regulations that restrict entry into the profession, hence restricting the supply of their services and raising prices. The effect of differences in the regulatory structure of occupational licensing on the interstate mobility of professionals have also been studied, with the primary result being the restriction of mobility as shown by Holen [1965], Benham, Maurizi, and Reder [1968], Pashigian [1979], Kleiner, Gray, and Greene [1982], Kugler and Sauer [2005], and Peterson, Pandya, and Leblang [2014]. These studies used data on the interstate mobility of professionals within the United States for various professions.

This paper revisits the effect of occupational licensing on professional mobility in the context of international migration. Occupational licensing is a form of domestic regulation subject to negotiations under the General Agreement on Trade in Services (GATS) in the World Trade Organization because some consider it as a trade barrier, particularly in the light of its anti-competitive effect. Occupational licensing and international migration are especially relevant under the GATS Mode of Supply 4, also called the Movement of Natural Persons (Mode 4). As yet, no empirical study is available on the relationship between occupational licensing and international migration, although many would assume that the extension of results from the aforementioned studies would be straightforward. However, in the case of international migration, the analysis is somewhat complicated by migration laws and regulations that are meant to control the entry of foreigners at the border.

This paper investigates the interaction between occupational licensing as a form of domestic regulation with Mode 4: Do foreign professional service providers engaged in international trade face occupational licensing as a non-tariff barrier?

Before responding to this question, it will be important to note that the movement of persons is not considered migration in the GATS. Rather, the movement of natural persons represents the mode of supply through which trade in services is undertaken. Thus, there is clear differentiation between migration and between international trade through Mode 4. By accepting this differentiation, the method proposed below will reflect the movement for trade in services rather than the movement for migration. Unfortunately, these two frameworks significantly overlap, especially when noting that border regulations clearly affect the ability of a foreigner to provide a service. It is in this sense that the proposed estimation is to be considered exploratory with the objective of differentiating migration-related regulation from occupational licensing that is a behind-the-border regulation.

The standard approach of estimating nontariff barriers applied to goods cannot be followed when analyzing professional services because their traded prices and quantities are not readily available. An indirect method, proposed here, tests whether and how much these regulations affect the decision by professionals of choosing a country for providing services internationally. Two regulatory indices—migration rules and professional practice rules—are treated as characteristics of 22 destination countries in a conditional logit model, using data on Filipino engineers working outside the Philippines between 1995 and 2001. This is the first study to use individual-level data to analyze such a problem.

As an initial conclusion, migration rules are found to explain the probability of choosing a destination country, although with an unexpected sign. Professional practice rules were also important and had a negative effect on the probabilities.

These results become even more meaningful when placed in the context of the GATS text and negotiations. The GATS focused on creating trade disciplines covering the regulation of the professions without explicitly discussing migration laws, rules, and regulations. These simple conclusions further indicate that trade and migration cannot be treated separately as is currently done under the GATS.

This paper is organized as follows. Section 2 presents a review of related empirical literature. Section 3 outlines the random utility maximization model, which is the basis of the conditional logit model, and presents the model specification. Section 4 shows the datasets, the sources of data, and the indices of regulation. There are two sets of regulations taken into consideration when studying the trade in professional services: the regulation of migration; and the regulation of the professions, which is mainly occupational licensing. Sections 5 and 6 present the estimation results and their interpretation. Section 7 discusses the limitations of the empirical exercise. Section 8 presents some conclusions.

2. A review of related empirical literature

The articles presented in this brief survey analyze the migration of professionals that estimate the effect of either migration policy variables or licensing and regulation policy variables on migration flows[1]. Given the vast literature on migration, this brief survey only highlights the chosen method of analysis: the regulatory variables used and some of the key conclusions related to said variables. The literature is split in two types: one set focuses exclusively on whether and to what extent occupational licensing inhibits mobility across regulatory boundaries; and the other set focuses on immigration laws and policies and the extent to which these inhibit mobility across international borders.

A section of the research focused on occupational licensing. The section isolates this regulatory variable by using data within a federated political system that allow states to determine their own occupational licensing frameworks. This strategy isolates occupational licensing from border controls and yet is able to study migration through interstate movement. The authors Benham et al. [1968] were the first[2] to empirically estimate the effect of occupational licensing on migration by looking at data on physicians and dentists in the United States. The results are consistent with expectations for dentists, but not for physicians. The

[1] A subset of this literature is interested in the impact of licensing on earnings and wages; many results indicate a wage premium associated with stricter licensing. Koumenta, Humphris, Kleiner, and Pagliero [2014] provide a short discussion that mostly covers work undertaken using American data.

[2] Holen [1965] is among the first to study the question of the effect of occupational licensing on migration, covering dentists, lawyers, and physicians in the 1949 census data for 23 states in the United States. She compares the ratio of the number of interstate migrants to number of intra-state migrants for each profession and finds that the ratio is higher for physicians compared to dentists and lawyers. This result is interpreted as arising from the licensing regulations and exclusionary practices of the states in the study. However, this hypothesis is not empirically tested.

authors argue that barriers for physicians may not be high enough considering the presence of reciprocity arrangements among states, thus softening the impact of regulations.

Pashigian [1979] broadens the questions to 34 professional occupations that bear a similarity with the legal profession within the United States. The paper has two innovations: it estimates probabilities; and it accounts for licensing by introducing dummy variables to represent three groups, namely, the absence of formal licensing, presence of formal licensing and reciprocity arrangements, and presence of formal licensing with stricter reciprocity arrangements. The results show that the two variables representing licensing with and with little or no reciprocity are negative and highly significant, resulting in a decline in the probability of an interstate move. Occupations with reciprocity have lower migration rates than unlicensed occupations.

Using data on migration flows of 14 licensed occupations, Kleiner, Gay, and Greene [1982] use a four-equation model to estimate the in- and out-migration rates of each profession by using a discrete index of licensing measures. The index ranges from zero (0), signifying that valid out-of-state licenses are recognized, to six (6), signifying that out-of-state practitioners have to go through the entire licensing process that domestic applicants experience. Intermediate values reflect the variations of the reciprocity arrangements between states. Applying the two-stage least squares method, the migration equations are found to be statistically significant with the index of licensing measures being significant and negative as expected.

The authors Peterson et al. [2014] follow Kugler and Sauer [2005][3] by focusing on residency requirements applied to international medical graduates wishing to practice medicine in the United States. The paper asks whether residency requirements influence the choice of a particular state for medical practice. Peterson et al. [2014] estimate Poisson pseudo-maximum likelihood count models for the dependent variable number of new international medical graduate admissions in the state for a given period against residency requirement that can take four distinct values: 0 months; 12 months; 24 months; or 36 months. The results were consistent with previous studies, even though the estimation strategy is very different.

Kuomenta, Humphris, Kleiner, and Pagliero [2014] report that the types of studies presented thus far are limited in the context of the European Union. The authors then proceed to estimate ordinary least squares (OLS) equations using the proportion of foreign-born workers in the occupation as the dependent variable

[3] Kugler and Sauer [2005] look at the specific aspect of the licensing framework—which is the retraining requirement required from foreign professionals wishing to practice in Israel—rather than the entirety of the regulatory framework. An OLS model and an instrumental variable model are estimated on the returns to acquiring a medical license. Their research does not study whether migration decisions or flows are affected.

and a dummy variable representing licensing as the key explanatory variable while controlling for other labor market indicators. In contrast to the results using American data, the empirical investigation undertaken by Kuomenta et al. [2014] does not show that licensing is a determinant of the foreign-born workers in the United Kingdom. No explanation is provided to explain the divergent result.

Meanwhile, Bloomfield, Bruggemann, Christensen, and Leuz [2015] look into the question somewhat differently. The paper estimates the effect of regulatory harmonization in the accounting profession among members of the European Union and finds that labor mobility increases after harmonization. The innovation in this approach is that no evaluation about differences in standards is made, but that differences in the application of a presumably common standard can still matter as a barrier to mobility.

While Kuomenta et al. [2014] do not find any evidence in their estimate, Fu and Hickey [2014], using Canadian data, find a positive relationship between immigrant participation and labor market regulation. Labor market regulation is represented by registration with the professional body, which is less strict than licensing. Professional bodies can then offer services to its members and increase the visibility of the profession to potential immigrants from outside Canada, increasing the potential for immigrant integration into that particular labor market.

The only[4] article that specifically studies trade in professional services is that of Nguyen-Hong [2000]. The study contains indexes of restrictions for 34 countries that affect the trade in legal (only 29 countries), accountancy, architecture, and engineering services. It shows occupational licensing as part of the set of regulatory measures; at the same time, the study includes some migration rules. This study also seems to be the first empirical investigation into the relationship between trade and regulation in professional services. Nguyen-Hong estimates the effect on engineering firms' price-cost margins of trade restrictiveness indices constructed on the assumption that trade barriers protect domestic firms and give them rent-creating advantages. The presence of these barriers can also add to business costs. OLS estimation of the price-cost margin is used on a cross-section of engineering firms in 20 countries. An industry approach to firm profitability, which takes into account firm-specific influences, is the basis for the model specification. The latter is extended to include the effect of trade barriers through the "collusion-concentration" relationship. The barriers to establishment—which typically "cover nationality, residency, recognition of foreign licenses and qualifications, partnership, form of establishment, and investment restrictions"—are positive and highly significant. On the other hand, the barriers to ongoing

[4] The study of Goyal and Mukherjee [2011] contains a discussion on domestic regulations and visa regimes as applied to architectural and engineering services in the trade between India and the European Union. However, the study does not attempt to estimate the effects of these regulations on the movement of architects and engineers between India and the European Union.

operations—typically, "the reservation of certain activities to the engineering profession, fee-setting regulations, licensing restrictions on management, and the temporary movement of people" [Nguyen-Hong, 2000:58]—are not significant.

Apart from Nguyen-Hong [2000], who incorporates some migration regulations in the indices that were created although not separately, other experts (Karemera, Oguledo, and Davis [2000]; Jasso, Rosenzweig, and Smith [1998]; Ortega and Peri [2013]) include immigration policy in their models of international migration, but they exclude occupational licensing. Focus is placed upon the variables used to represent immigration law and the results.

The authors Jasso et al. [1998] investigate the effect of changes in American immigration laws on the number and skill levels of legal immigrants found in a panel dataset using the records of the Immigration and Naturalization Service for the period 1972 to 1995. Different dummy variables are used to represent changes in the immigration law regimes: "(i) integration of the two hemispheres [East and West] into a single worldwide visa allocation system, including the physician restriction provision,…; (ii) IRCA [Immigration Reform and Control Act of 1986] legalization and marriage fraud restriction, …" [Jasso et al. 1998:30], which later are defined according to Eastern or Western hemisphere. Only the marriage fraud-IRCA legalization dummy variable is statistically significant with the expected negative sign.

Karemera et al. [2000] estimate a gravity model of migration, which is a reduced form of a system of supply and demand equations. This equation is estimated for pooled cross-country data of 70 countries over the time period 1976-1986, which shows the migration flows from 70 countries into the United States and Canada. The authors use dummy variables "to identify the effects of the US immigration policy changes of 1976, 1980, and 1986 on migrant flows to the USA" and for the "effectiveness of the Immigration Acts of 1976 and 1978" in Canada [Karemera et al. 2000:1748]. The immigration policy variables are significant with the expected negative signs and indicate high elasticities. They interpret this result to mean that the immigration policies were able to effectively restrict migration into Canada and the United States.

Finally, Mayda [2010] uses migration inflows into OECD-member countries and looks into the effect of changes in migration policies in receiving countries. Unfortunately, migration policy is not a separate independent variable; it is the interaction effect of migration policies, represented as migration quotas, with a variety of push and pull factors. The results are consistent with most other migration models.

The literature surveyed uses various approaches for understanding the relationship between occupational licensing and migration. Our interest here is to explore to what extent the conclusions from these studies can be extended into a setting of international migration, specifically migration from developing countries into developed countries. More importantly, this study wishes to distinguish between the effects of border controls from occupational licensing in keeping with the framework of the GATS where negotiations over commitments to Mode 4 exclude border controls.

The estimation method for testing the possible relationships is dictated by the nature of the available dataset[5]. A conditional logit model is used because the dataset is one of Filipinos working abroad and the regulations of interest can be considered characteristics of the chosen destination country in the same way that Davies, Greenwood, and Li [2001] study non-economic factors of interstate migration in the United States. Their conditional logit model estimates the probability that an individual will move from one state to another by using population, unemployment, incomes, distance, and state dummy variables as explanatory variables. Population, per capita income, and the non-migration dummy are positive as expected. The unemployment rate has a negative sign. Distance and distance squared also behave as expected, showing a U-shaped relationship with the probability of moving.

Previous migration models fail to consider that part of the population who did not succeed in migrating. Therefore, the effects of the policy variables on those who were left behind were not investigated. In other words, the question being investigated can be reformulated into a success or failure test, that is to say that a professional service provider able (resp., unable) to trade internationally through movement across international borders succeeded in passing (resp., failed) the test of migration and occupational licensing. The dataset being used in this paper only represents those who succeeded. Conditional logit takes into account this characteristic of the dataset. [6]

3. The random utility maximization model

In a discrete choice situation, maximizing utility from a choice requires the decision maker to compare the utility levels that each discrete alternative has, with the one with the highest utility level being chosen. Let U_{ij} be the utility level individual i attaches to alternative j in the set of J alternatives faced by i.

Each utility level can be divided into a deterministic component, V_{ij}, and a stochastic component, ε_{ij}, giving us Equation 1. The deterministic component can be defined by any number of characteristics of the individuals as well as the characteristics of the alternatives. The deterministic component is estimated to measure the probability P_{ij} that i will choose alternative j. This probability is equal

[5] The gravity model was considered, but this model requires migration data on more than one supplying country in order to be meaningful as a system of demand and supply equations. Estimating an earnings function based on remittances data so that a parallel to the price-cost margin can be created is another possible approach. However, this approach will require a comparison with the earnings function of professionals in the host country, for which data is not readily available.

[6] Its extension to the nested logit model is discussed in Section 6.

to the probability that U_{ij} is the largest of all the utility levels, $U_{i1},\ldots,U_{iJ.}$ Thus, we can write the following equation.

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

Finding the highest utility level is equivalent to finding the smallest difference in the corresponding error terms when comparing the differences in the deterministic utility levels between alternative j and all the other k alternatives, as illustrated in Equation 2. Since the probability depends on the stochastic component, the assumptions on the error distribution are crucial. The error distribution that is eventually assumed to hold will determine the scale of the utilities and how the probabilities are computed and interpreted. The conditional logit model and the random utility version of this logit model have closed-form solutions facilitating the estimation process.

$$\begin{aligned} P_{ij} &= \Pr(y_i = j) = \Pr(U_{ij} > U_{ik}) \ \forall\ k = 1, \ldots, K, J : k \neq j \\ &= \Pr(\varepsilon_{ik} - \varepsilon_{ij} \leq V_{ij} - V_{ik}) = \forall\ k\ 1, \ldots, K, J : k \neq j \end{aligned} \tag{2}$$

The addition of a constant does not change the probability outcomes. Also, multiplying the utilities by a constant does not change the probability outcomes. The last note means that the scale of the utilities is not defined, and, therefore, the random utility maximization models have to normalize the utilities [Heiss 2002:229].

The determinants of the deterministic component of alternative j are a combination of alternative-specific constants α_j , individual-specific variables contained in the vector z_{ij}, and alternative-specific variables summarized in the vector x_{ij} for $i = 1, \ldots, I$, and $j = 1, 2, ..., J$.

V_{ij} can now be written as

$$V_{ij} = \alpha_j + x_{ij}^T\beta_j + z_i^T\gamma_j \tag{3}$$

where β_j and γ_j are vectors of coefficients.

Generic variables may enter into the equation when there is variation of x_{ij} over the alternatives. In this case, a joint coefficient β for all the alternatives is estimated and the restriction is expressed as

$$\beta_j = \beta \qquad \forall\ j = 1, \ldots, K, J \tag{4}$$

The random utility model described above becomes a conditional logit model when the error terms are assumed to be independently and identically distributed as Extreme Value Type I with a variance $\sigma^2 = \pi^2 / 6$. This error distribution assumption implicitly assigns the scale of the utilities and simplifies its interpretation. The chosen scale is unimportant because it is the ranking or the ordering of the utilities that determines the choice. With this error distribution, it is possible to express the probabilities as follows [McFadden 1974]:

$$P_{ij} = e^{V_{ij}} / \sum_{k=1}^{J} e^{V_{ik}} \tag{5}$$

Equation 5 expresses the conditional logit probability as a ratio of the utility level of the chosen alternative j to the sum of the utilities of all other alternatives.

The assumption that the errors are independently distributed corresponds to the assumption of independence of irrelevant alternatives (IIA), which some consider restrictive. When two alternatives are similar, their errors are likely to be positively correlated. In other words, the addition of another alternative similar to at least one other alternative could change the final choice. The original assumption is that the additional alternative should not. For this reason, the conditional logit model is recommended only where choices are highly dissimilar and cannot substitute for one another [Long 1997].

A conditional logit model of choice among a set of destination countries for providers of engineering services is an indirect method of identifying the effect of the regulatory system on the trade in engineering services. The question is whether these regulatory policies affect the ability of a professional to provide a service in a foreign country by impinging upon the decision process. The provision of services internationally is incumbent upon a migration decision: it is difficult to provide a professional service without the provider being physically located at the point where the service is required[7]. The temporary migration of the professional is equated with a trade in a service since the foreign provider stays in the host country temporarily and never receives the same rights and privileges as a permanent resident or a national. The difference is reflected in the way the regulatory system differentiates between the domestic provider and the foreign provider. The engineers are expected to participate in the services market and not in the labor market of the destination country. This treatment of trade and migration tries to remain consistent with the GATS, especially its Annex on the Movement of Natural Persons.

The following conditional logit probability function for an engineer from the Philippines providing services to country j for every year in the pooled dataset is to be estimated.

[7] Some services can be provided over the telephone or other form of communication, but this will not be the case in most types of services, especially professional services.

$$P_j = e^{\beta x_j + \alpha z_j + \gamma w_j + \theta w_j^2 + \delta' v_j} \Big/ \sum_{j=1}^{J} e^{\beta x_j + \alpha z_j + \gamma w_j + \theta w_j^2 + \delta' v_j} \quad (6)$$

where

x_j = Gross national income per capita of the destination country j

$z_j = (z_1, z_2, ..., z_j)$ is the vector of country-specific dummy variables

w_j is the distance in kilometers between the Philippines and country j

$v_j = (v_1, v_2)$ is the vector of regulatory indices for migration and professional practice, respectively, for each country j.

The set of attributes of the choices will be as follows: (1) the migration regulations index; (2) the professional practice index; (3) the cost of movement (using distance as a proxy); (4) the income of the choice country (expressed in per capita terms and in logarithmic form); and (5) a set of country-specific dummy variables.

Attributes 1 and 2 are constructed from the indices in Nguyen-Hong [2000][8] and are described below. Immigration rules are expected to have a negative effect on the provision of services, primarily because immigration rules, which serve as the main set of border controls, are meant to control the entry of foreigners, regardless of purpose of entry. There are cases, however, when immigration rules have been adjusted to meet labor shortages in the host countries. Professional qualification rules, such as occupational licensing, are expected to have a negative effect in the same way as the above-mentioned studies.

In general, attribute 3 seeks to measure direct costs of transfer, which are mainly recruitment costs and travel costs. An inverse relationship is expected with high costs leading to a lower probability of being chosen. A proxy variable, distance in kilometers from Manila, Philippines to the capital city of the destination country, is used given the difficulty of estimating this cost. The square of the distance variable is meant to reflect a possible U-shaped relationship between distance and the probability of choosing a destination country. Distance was calculated using the distance calculator found in http://www.indo.com/distance/.

Attribute 4 is an indicator of attractiveness of the choice country for engineers. It can also be a variable representing the level of demand for imported engineering services in the host country. A direct relationship is expected. The data for gross national income per capita comes from the World Development Indicators 2002 CD-ROM [World Bank 2002], expressed in US dollars at purchasing-power parity.

[8] Note that the professionals can enter a country through various routes such as contract worker, intra-company transferee, tourist or business entry, and so on.

Gross national income per capita is matched with the country and year that the engineer departed for his or her destination. Finally, a set of country-specific dummy variables is included in the estimation to capture fixed-effects associated with a country that could not be captured by the other variables.

4. The dataset

The data used for the estimation is the pooled subsets of engineers in each of the annual Survey of Overseas Filipinos (SOF) conducted between 1995 and 2001. It is the sub-sample of individuals who are in the working age population (15-65 years old), whose occupation abroad was engineering and related professionals or physical science and engineering technicians, whose reason for leaving was not for emigration nor for work with diplomatic missions, and who departed between April and September of the year of the survey. Tourists are included as long as they were reported as working abroad[9].

The limited number of observations for each year of the survey required pooling of datasets to improve the degree of freedom for estimation. Pooling the datasets, however, means that serial correlation is assumed to be absent. Serial correlation may be addressed by adding a dummy variable for the year of the survey, but doing so will place an additional strain on the degrees of freedom.

The number of engineers who were overseas workers between 1995 and 2001 was 450. They went to 46 countries. Not all of these engineers are included in the estimation because there is information on the regulatory indices for only 22 countries, which means that the sample size available for estimation is only 135 observations. The major weakness in this study is that the full range of choices cannot be included in the estimation. For example, Saudi Arabia alone accounts for 42.4 percent of all engineers who worked abroad between 1995 and 2001, but there is no readily available information on Saudi Arabia's regulatory structure.

Following previous studies that tried to quantify the effects of regulatory measures on the services trade, two indices are created, representing the regulation of migration and the regulation of the professions. The regulatory indices are based on those in Nguyen-Hong [2000] and are assumed to have been stable over the 7-year period covered by the empirical investigation, which may be justified by the high transaction costs of changing a law in a country with some form of representative democracy. Confirmation of "system-stability" is provided by Paterson, Fink, and Ogus [2003], at least for members of the European Union[10].

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9 There were 2 out of the 135 observations with this characteristic.

10 The authors Paterson et al. [2003] compute a different set of indexes for members of the European Union. Their set contains different categories of regulations, is more recent, and uses a different weighting system. Engineering was found to be the least regulated among the professions covered in their study.

The quality of the indices clearly depends on the ability to create a database of regulations that is as comprehensive as possible to allow for detailed comparisons. An added difficulty is that the comparison will be nominal or *de jure* rather than actual or *de facto* practice[11].

With this in mind, Nguyen-Hong [2000] studied the restrictiveness of professional services and created indices for the accounting, legal, engineering, and architecture professions. From Nguyen-Hong [2000], two new indices were created after removing some components and reclassifying others for purposes of the econometric test. The components of these new indices and their associated weights are given in the Table 1 below.

TABLE 1. Restriction Categories and Corresponding Weights for the New Indices

Restriction Categories	Weight for Foreign	Re-scaled Foreign	Weight for Domestic	Re-scaled Domestic
Migration Regulations Index	0.400	1.000		
Nationality requirements	0.135	0.3375	N.A.	
Residency & local presence requirements	0.135	0.3375	N.A.	
Quotas/economic needs test	0.100	0.2500	N.A.	
Permanent movement of people	0.020	0.2500	N.A.	
Temporary movement of people	0.010	0.2500	N.A.	
Professional Practice Index	0.340	1.000	0.250	0.7355
Activities reserved by law to the profession	0.050	0.1471	0.050	0.1471
Multi-disciplinary practices	0.050	0.1471	0.050	0.1471
Advertising, marketing and solicitation	0.050	0.1471	0.050	0.1471
Fee setting	0.050	0.1471	0.050	0.1471
Licensing requirements on management	0.020	0.0588	N.A.	
Licensing and accreditation of foreign professionals	0.100	0.2940	N.A.	
Licensing and accreditation of local professionals	N.A.		0.050	0.1471
Other restrictions	0.020	0.0588	N.A.	

[11] Dixon [2012] discusses how firms may circumvent formal rules on qualifications of engineers and the possibility that firms may give less weight to such qualifications than suspected. A similar discussion is found in Finotelli [2014], not only for engineers but also for information technology specialists and physicians. There have also been developments in the recognition of qualifications of skilled migrants as discussed in Hawthorne [2013].

In Nguyen-Hong [2000], the barriers to establishment index contain categories that applied to firms rather than individuals. These categories are no longer included in the new indices. The categories that have been removed are as follows: form of establishment; foreign partnership or joint venture; investment and ownership by foreign professionals; and, investment and ownership by non-professional investors. Then two categories from the establishment index were moved to what is now the professional practice index: licensing and accreditation of foreign professionals; and licensing and accreditation of local professionals. One category from the barriers to ongoing operations index was moved to what is now the migration regulations index; this category was the temporary movement of people. Table 1 below shows the categories and their respective weights in Nguyen-Hong [2000]. All the categories retained their weights, but these have been re-scaled to bring the full score to a maximum of one.

The formulas used to recalculate the new indexes for the econometric test are as follows:

- Foreign migration index = (Foreign establishment index – 0.46 Foreign establishment index) + 0.01 Foreign ongoing operations index
- Foreign practice index = (Foreign ongoing operations index – 0.01 Foreign ongoing operations index) + 0.10 Foreign establishment index
- Domestic practice index = Domestic ongoing operations index + 0.05 Domestic establishment index

The net professional practice index is the difference between the foreign practice index and the domestic practice index.

Table 2 shows the summary statistics for the variables in the conditional logit model. The dependent variable is destination. The variable names follow: log of gross national income per capita (*lngnipc*); distance (*distance*); distance-squared (*distsq*); foreign migration index (*fmigidx*); foreign practice index (*fpracidx*); domestic practice index (*dpracidx*); net professional practice index (*pracidx*); North and Northeast Asia (*nneasia*); South and Southeast Asia (*sseasia*); Western Europe (*weurope*); North America (*namerica*); and Australia and New Zealand (*ausnz*).

TABLE 2. Table of Summary Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
lngnipc	135	9.8366	0.6117	7.6401	10.44232
distance	135	5747.696	4547.569	1013	13792
distsq	135	5.36E+07	6.97E+07	1026169	1.90E+08
fmigidx	135	0.1634	0.0808	0.0128	0.375
fpracidx	135	0.1897	0.1191	0.0321	0.5274
dpracidx	127	0.1335	0.1232	0.0015	0.4489
pracidx	127	0.0642	0.0212	0.0123	0.1494
nneasia	135	0.2741	0.4477	0	1
sseasia	135	0.3778	0.4866	0	1
weurope	135	0.1704	0.3774	0	1
namerica	135	0.1630	0.3707	0	1
ausnz	135	0.0148	0.1213	0	1

For this paper, the utilities estimated are those that the engineers attach to a destination. Estimating these utilities allows for an estimation of the probability of choosing a particular destination country given that country's set of characteristics. In particular, the estimated model can show whether a country's migration regulation and professional practice regulation can affect the probability that a foreign engineer will choose that country to provide trade in services.

Models that use country-specific dummy variables face problems with collinearity such that the two regulatory indices and some of the country dummy variables are consistently dropped during estimation. The problem arises from the large number of categorical explanatory variables being estimated against a categorical dependent variable using a small sample size. Given this problem, the models presented below use region-specific dummy variables, where the countries are grouped into five geographical sub-regions, namely Australia and New Zealand, Western Europe, North America, North and Northeast Asia and South and Southeast Asia.

5. The results

The succeeding sections present the coefficients and corresponding standard errors and *p*-values (Table 3), the Wald tests for joint insignificance of variables (Table 4), the Hausman test for independence of irrelevant alternatives, and the measures of fit for two models. Model 1 uses the foreign practice index. Model 2 uses the net professional practice index, which is the difference between the foreign professional practice index and the domestic professional practice index.

TABLE 3. Table of coefficients, standard errors, and p-values

Variable	Model 1		Model 2	
	Coefficients	$p > \|z\|$	Coefficients	$p > \|z\|$
lngnipc	1.4231 (0.2157)***	0.000	1.5540 (0.2691)***	0.000
distance	0.0006 (0.0003)**	0.027	0.0009 (0.0003)**	0.002
distsq	-2.39e-08 (2.25e-08)	0.287	-4.52e-08 (2.44e-08)	0.063
fmigidx	3.8031 (1.4200)**	0.007	10.2366 (2.7421)***	0.000
fpracidx	1.0022 (1.0871)	0.357		
pracidx			-21.2926 (8.1261)**	0.009
ausnz	-5.131303 (1.1281)***	0.000	-4.1315 (1.3115)**	0.002
weurope	-5.2476 (1.4621)***	0.000	-4.5744 (1.7833)*	0.010
nneasia	-0.7674 (0.3267)**	0.019	-0.3892 (0.2889)	0.178
namerica	-4.0848 (2.4624)	0.097	-2.2497 (3.0613)	0.462

For both models, the logarithm of gross national income per capita (*lngnipc*) is highly significant with the expected positive sign[12]. This result is consistent with Karemera, Oguledo and Davis [2000], Davies, Greenwood, and Li [2001], and Mayda [2010].

The distance variable (*distance*), a typical proxy for the cost of departure, is significant at the five-percent level in both models but with the "wrong", i.e., a positive, sign. The positive relationship seems to run contrary to the results of the authors Karemera et al. [2000] who find a negative relationship. Distance-squared (*distsq*) is not statistically significant in both Models 1 and 2, again, contrary to the results of the authors Davies et al. [2001] who find a U-shaped relationship for distance. These results suggest that distance may actually be a poor variable to measure costs in the Philippine case. Indeed, some temporary contracts specify that employers or business partners internalize the cost of travel to and from the host country. Nor do differential costs of air-travel—the relevant mode in this case—always reflect differences in distances; rather these may be complicated by seasonality and other pricing practices of the airline industry. More importantly, one cannot discount the possibility that migrants consider travel costs as a form of fixed costs, the importance of which declines when spread over many years of employment. If higher-paying destinations also happen to be more distant (e.g., Saudi Arabia versus Malaysia), then "distance" may actually capture differences in potential earnings[13];

[12] The results do not differ significantly if gross national income per capita (Atlas Method) is used.
[13] That is, apart from the differentials captured in the income variable *lngnipc*.

the "perverse" result thus becomes plausible. As will be discussed further below, distance also has a negligible contribution to the log-odds ratios.

As for the variables of particular interest, the foreign professional practice index (*fpracidx*) in Model 1 is statistically insignificant. However the net professional practice index (*pracidx*) is statistically significant at the five-percent level in Model 2 with the expected negative sign: the larger the difference between the professional practice requirements of a local against a foreign engineer, the less likely that a foreign engineer will choose to provide services in that country. The direction of change in Model 2 is consistent with the results of studies discussed above on the effect of occupational licensing on the mobility of professionals. Wald tests further indicate robustness of these results.

TABLE 4. Wald tests on the coefficients of the distance variables and regulatory variables

Wald tests on the distance variables	
Model 1	Model 2
H_o: $\boldsymbol{\gamma}=\boldsymbol{\theta}=0$ $\chi^2(2) = 6.27$ Prob > $\chi^2 = 0.0436$	H_o: $\boldsymbol{\gamma}=\boldsymbol{\theta}=0$ $\chi^2(2) = 9.64$ Prob > $\chi^2 = 0.0081$
Wald tests on the regulatory indices variables	
H_o: $\boldsymbol{\delta}^1=\boldsymbol{\delta}^2=0$ $\chi^2(2) = 13.31$ Prob > $\chi^2 = 0.0013$	H_o: $\boldsymbol{\delta}^1=\boldsymbol{\delta}^3=0$ $\chi^2(2) = 14.97$ Prob > $\chi^2 = 0.0006$

The migration regulations index (*fmigidx*) is statistically significant at the five-percent level in Model 1 and at the one-percent level in Model 2 although in both cases it is associated with a positive coefficient, contrary to expectation. However this result, interestingly enough, is consistent with the findings of Nguyen-Hong [2002]. In that paper, foreign barriers to establishment (the source of the migration regulation index for this paper) led to an increase in price-cost margins for engineering firms, which was interpreted to mean rents associated with protection due to the high barriers. Thus "rents" may be associated with high migration barriers. This may partly explain the perverse result that high migration barriers raise the probability of a country being chosen by a migrant engineer—the reason being that it is associated with positive rents accruing to the profession when practicing behind the barriers.[14]

[14] One might also consider the possibility that successful migrants find ways to skirt the restrictions covered by the index (e.g., through family reunification programs), or that the barriers themselves are not high enough to be binding. Either of these, however, is more likely lead to insignificant coefficients and will not explain the positive and significant results reported here. (I thank an anonymous referee for pointing this out.)

Among the region-specific dummy variables (with South and Southeast Asia being the reference region), Australia-New Zealand (*ausnz*) and Western Europe (*weurope*) are significant at the one-percent level in model 1. In model 2, *ausnz* is statistically significant at 5 percent, while *weurope* is statistically significant at 10 percent. Both regions have negative signs, which mean neither region is a preferred destination compared with South and Southeast Asia. North America (*namerica*) and North and Northeast Asia (*nneasia*) are insignificant in all models (with negative signs).

The conditional logit model is limited by having to assume the independence of irrelevant alternatives, as already explained above. Hausman tests for Models 1 and 2 suggest that IIA cannot be rejected. For some destination countries, the test statistics have negative values (Singapore and the United Kingdom for Model 1 and Australia for Model 2), which cannot happen in a chi-squared distribution. [See Table 5.]

TABLE 5. Hausman's test statistic for IIA

Country	Model 1	Model 2
Australia	17.44	-3.51
Austria	32.34***	2.08
Belgium	0.42	0.00
Canada	1.77	11.30
Denmark	0.34	0.62
France	4.03	0.00
Germany	3.71	22.24**
Greece	3.45	0.91
Hong Kong	1.56	14.50
India	8.02	1.10
Indonesia	6.49	11.74
Italy	7.31	2.94
Japan	7.93	1.40
Korea, South	28.55***	0.00
Malaysia	21.47**	0.00
New Zealand	2.08	4.52
Singapore	-11.62	1.87
Spain	6.57	18.48*
Switzerland	0.41	1.39
Thailand	1.54	4.63
United Kingdom	-2.69	8.77
United States	32.56***	8.01

A set of scalar measures of fit is presented in Table 6. Here we merely note that the log-likelihood ratio for a constant-only model shows that both models are significant. Model 2 appears to be the better model than Model 1. However it is worth noting Long's [1997:102] caution against the interpretation of scalar measures of fit in categorical limited dependent variable models.

TABLE 6. Comparing measures of fit

Measures of fit	Model 1	Model 2
Log-likelihood intercept only	-417.291	-373.944
Log-likelihood full model	-347.901	-304.667
Log-likelihood ratio (degrees of freedom)	138.778 (9)	138.554 (9)
Prob > LR	0.000	0.000
Deviance (degrees of freedom)	695.803 (126)	609.333 (118)
McFadden's R^2	0.166	0.185
McFadden's Adjusted R^2	0.145	0.161
Maximum Likelihood R^2	0.642	0.664
Cragg & Uhler's R^2	0.644	0.666
Akaike Information Criterion	5.287	4.940
AIC * n	713.803	627.333
Bayesian Information Criterion	77.738	37.719
BIC'	-94.631	-94.956

6. A partial solution to IIA: a nested logit model

Notwithstanding the results of the Hausman tests, we address the possible limiting assumption of the conditional logit model by also attempting a nested logit model. The nested-choice model allows similar alternatives to be grouped together so that these can have correlated error terms, thus, relaxing the assumption of independence.

In the nested-choice model, the alternatives are grouped into M subsets, where each subset is called a nest B, so that we have B_m, $m = 1, \ldots, M$. Each nest may be subdivided further to form levels of nests. The chosen alternative j belongs to one of the nests $B(j)$ in the following way.

$$B(j) = \{B_m : j \in B_m, M = 1,\mathrm{K}, M\} \tag{7}$$

The choice probabilities are expressed in the following way.

$$P_j = \Pr(y = j) = \Pr\{y = j \mid y \in B(j)\} \times \Pr\{y \in B(j)\} \tag{8}$$

If the alternative that is chosen is denoted as y, then the probability that y happens to be alternative j is the product of the probability that y will be found in nest $B(j)$ and the probability that y is in nest $B(j)$ on condition that an alternative belonging to $B(j)$ was chosen.

6.1. The nested logit model

A generalized extreme value distribution for the error terms is assumed in a nested multinomial logit model which allows for alternatives within the same nest to have correlated error terms so that for each nest $m = 1,\ldots, M$ an additional parameter τ_m is added to the joint distribution of the error terms. This additional parameter is a measure of correlation among the error terms and may be specified as $\sqrt{1-\rho_m}$, where ρ_m is the correlation coefficient. The parameter τ_{m} is an inverse measure of correlation that may be interpreted as a dissimilarity parameter.

In a nested logit model, therefore, the estimated probability from the conditional logit model must be adjusted to reflect the correlation of the error terms. That is to say that the dissimilarity parameter is used to normalize the utilities so that each nest becomes comparable otherwise each nest would be scaled by a different factor because of the correlation in the error terms. Thus, the conditional probability of choosing alternative j, given that the individual chose nest $B(j)$, is expressed as follows.

$$\Pr\{y=j \mid y \in B(j)\} = e^{V_j/\tau(j)} \Big/ \sum_{k \in B(j)} e^{V_j/\tau(j)} \tag{9}$$

If one takes the log of the denominator of Equation 9 for each nest m, then we have the inclusive value (IV) parameter given by Equation 10. The IV parameters give the expected values of the utility from the alternatives found in nest m.

$$IV_m = \ln \sum_{k \in B_m} e^{V_k/\tau_{\mathrm{m}}} \tag{10}$$

The probability that the choice y is in nest $B(j)$ will be the conditional logit probability of the choice among the nests. In this case, the rescaled inclusive value parameters become the deterministic component of the utility from choosing a particular nest.

$$\Pr\{y \in B(j)\} = e^{\tau_m IV_m} \Big/ \sum_{m=1}^{M} e^{\tau_m IV_m} \tag{11}$$

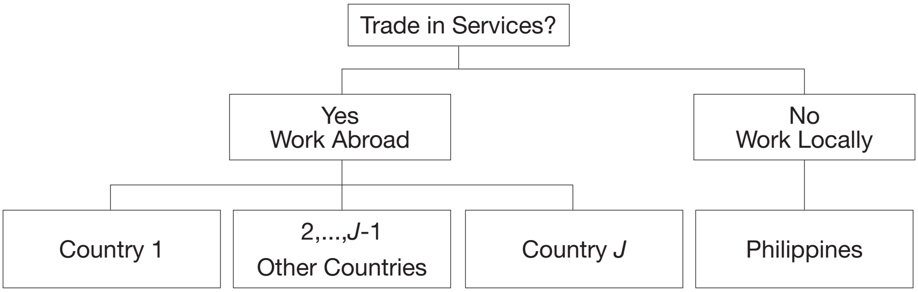
Equations 9 and 11 are the elements of Equation 8. Thus, the marginal choice probability for alternative j can be expressed as:

$$P_j = \left(e^{V_j/\tau(j)} \Big/ e^{IV(j)} \right) \times \left(e^{\tau(j) IV(j)} \Big/ \sum_{m=1}^{M} e^{\tau_{\mathrm{m}} IV_{\mathrm{m}}} \right) \tag{12}$$

From Equation 12, it is evident that the conditional logit model becomes a special case where $\tau_{\mathrm{m}} = 1$, $\forall\ m = 1, \mathrm{K}, M$.

6.2. Specifying a nested logit model

The following decision tree illustrates the nested logit model to be estimated.



At the top level are two nests. In the nest corresponding to the "yes" response, the bottom level has *J* alternatives corresponding to possible choices of destination countries. In the nest where the response is "no", there is only one terminal alternative. The top-level nest has individual-specific characteristics as the only set of explanatory variables. This would be similar to estimating a logit model of the decision to migrate. The demographic variables entering the top level are: sex (*male* = 1, and 0, otherwise), age (*age*), age-squared (*age2*), civil status (*single* = 1, and 0, otherwise), and relationship to head of household (*head* = 1, and 0, otherwise). Some of the push variables that have been associated with migration, such as household income or wages, have not been included since this type of information is not available from the dataset. The second-level nest is estimated with destination-specific constants and generic variables, the same set of variables in the conditional logit model discussed above.

The model specification has two characteristics. The first is the presence of a degenerate nest, where there is only one alternative. In this case, the dissimilarity parameter loses meaning for obvious reasons. The second is the exclusive use of generic variables and alternative-specific constants. There is no data on alternative-specific characteristics that vary across the individuals.

6.3. Results of nested logit model estimation

A nested logit model using region dummy variables was estimated using gross national income per capita (Atlas method)[15]. In this model, the inclusive value parameter associated with the degenerate nest (to remain) is set equal to one, implying that there is no correlation problem among the choices. It also means that the expected utility attached to choosing the Philippines conditional on the

[15] Regression runs were undertaken using the PPP dollar method for gross national income per capita, but several parameters were not estimated.

choice to remain is one.

The log-likelihood ratio test against a constant only model shows that the nested logit model is significant. The log-likelihood ratio test on a null hypothesis that the conditional logit model is the more appropriate specification can be rejected for this model at the 1 percent level. The results of the estimation are presented in Table 7.

TABLE 7. Estimated coefficients, standard errors, and *p*-values of the NLM

Levels = 2
Dependent variable = destination
Log likelihood = -758.94686

Number of Observations = 57980
LR chi2(14) = 15851.36

	Coefficient	Standard Error	*z*	*p* > |z|	[95% Confidence Interval]	
alt						
lngnipc	0.885	0.155	5.720	0.000	0.582	1.189
distance	0.000	0.000	2.080	0.037	0.000	0.001
fmigidx	10.292	2.816	3.650	0.000	4.773	15.810
pracidx	-20.737	8.395	-2.470	0.014	-37.192	-4.283
nneasia	-0.458	0.293	-1.560	0.118	-1.033	0.116
weurope	-5.202	1.445	-3.600	0.000	-8.034	-2.370
ausnz	-3.520	1.275	-2.760	0.006	-6.019	-1.020
namerica	-4.531	2.033	-2.230	0.026	-8.514	-0.546
migrant						
male	1.741	0.406	4.290	0.000	0.946	2.536
age	0.410	0.089	4.620	0.000	0.236	0.584
age2	-0.004	0.001	-3.870	0.000	-0.006	-0.002
single	-0.676	0.257	-2.630	0.008	-1.180	-0.173
head	-2.413	0.241	-10.000	0.000	-2.887	-1.941
(inclusive value parameters)						
migrant						
/overseas	-0.534	0.226	-2.380	0.017	-0.979	-0.094
/remain	1.0000	.	.	.	.	.
LR test of homoskedasticity (iv=1): chi2(1)=114.97 Prob>chi2= 0.000						

In the top level nest for migrant (1, if *migrant* and 0, otherwise) the variable for head of household (*head*) was significant at the one-percent level with a negative sign indicating that heads of households are not likely to migrate in the model estimated. *Male*, *age*, and *age2* were also highly significant. *Male* had a positive sign while *age* showed the expected inverted-U relationship with the probability to migrate. *Single* was significant at the 10- percent level with a negative sign. In general, therefore, a higher probability of migration is attached to married, young males who are not heads of households. The last characteristic may indicate that the migrant engineers lived in multiple generation households.

At the bottom-level nest for the destination countries, *lngnipc* was highly significant with the expected positive sign, consistent with the conditional logit models above. *Distance* was insignificant, a result differing from those of the conditional logit models above. This result emphasizes that distance may not be an important variable in the decision to choose a destination. More significantly, this result also bolsters our previous conjecture that the variable *distance* in the conditional logit model tends to capture more of the occupation-related differentials in earnings rather than travel-related costs affecting migration. The variable *fmigidx* was significant at the one-percent level with a positive sign, as it also did in the previously estimated conditional logit models[16]. Similarly significant at the five-percent level was *pracidx* with the expected negative sign. Among the region-specific dummy variables in the model, only *weurope* was significant, with a negative sign indicating that it was not a preferred destination compared to the reference region *sseasia*. Meanwhile, *ausnz* and *namerica* were significant at the 5 percent level with a negative sign; *nneasia* was not statistically significant.

In general, therefore, the nested logit model exercise has only tended to confirm what was already reflected in the conditional logit model, particularly for the variables of interest, *fmigidx* and *pracidx*, although this time under less restrictive econometric assumptions.

7. The limitations of the exercise

Future work using either the conditional logit or the nested logit model should take into account the difficulty of obtaining world prices and quantities for internationally traded professional services. It is this factor which makes it difficult to use generally accepted methods of estimating non-tariff measures, as well as the methods associated with price, quantity, and quality impact assessments after regulatory reform. Data on the balance of trade are not yet disaggregated enough to allow an assessment of the openness of a country using export and import levels of professional services.

Assessing the effect of regulations on the level of openness of a country using choice theory in the context of a temporary migration decision is offered as an indirect method. Inferences for trade policy from this indirect method can only be treated with caution, since the relationship between decision-making and trade policy is not clearly laid out.

This limitation is dictated by the high cost associated with obtaining a quantitative expression for the regulatory systems in place of all possible country choices. This was the main difficulty faced by negotiators in the World Trade Organization and drives some of the demands behind calls for "transparency in regulation" since the demand can be translated into an offer of providing the necessary legal information to all trading partners as a matter of obligation under the GATS.

[16] The indexes in this model will also need to be re-scaled.

At the level of the individuals who are potential service providers, information is lacking regarding the value that these potential migrants place on each choice, which is why the models only incorporate generic variables.

The estimated conditional logit model is not a fully developed migration model nor was it meant to be one. It fails to incorporate push and pull factors that could also explain the decision to migrate. Furthermore, push factors of migration can differ significantly between time periods. For example, economic crises may influence the decision to migrate or may lead to lower migration rates due to higher costs of foreign exchange. It was pointed out that such push factors are not available for the individuals in the sample preventing the study from saying anything further on this point.

The uneven number of observations in the cells may result in biased estimates because of the weights that they implicitly create. In other words, for some years and some countries, there were no engineers observed to have been working abroad.

Repeated cross-sections needed to be pooled owing to the small sample size for a single-year cross-section analysis. Hence, it was necessary to resort to region-specific dummy variables rather than country-specific dummy variables that would have allowed for cross-country comparisons of the regulatory structures. The above-mentioned estimations meet the minimum requirements for the number of observations, but caution is the preferred approach because the sample size is only 135 and not the “adequate” size of 500 or more [Long 1997:54]. Hence, significance at the 10-percent level for the some of the variables in the estimated models above may have to be taken with greater caution than usual. While this limitation was passed by the nested logit model, the unbalanced nature of the dataset should also be kept in mind.

Not all the regulatory information relevant to the trade in engineering services is covered by the indices, although they do contain the most important ones. The migration index is particularly weak in that it does not contain visa fees, length of validity, and the like. To what extent reciprocity is practiced among countries is also not known. Other missing information are the transactions costs and opportunity costs paid for by the potential migrants to gain entry to foreign services markets.

One of the biggest challenges in creating indices is the choice of weighting structure. At this point, no unbiased procedure exists to ascertain which of the rules are more important than others. Future work in this area may require experiments with weighting structures if only to test the sensitivity of the resulting estimates.

8. Conclusions

The evaluation of the effect of regulations on the trade in services depends largely on one’s confidence in the quality of the information behind the index, as well as the arbitrary choices behind the weights. Almost every study interested in quantifying the results of trade liberalization in services has no recourse but to use indices despite their well-known problems. This research contributes to the discussion by investigating the possible impact of these regulations on the movement of persons by changing the composition of the indices to distinguish migration rules from occupational licensing.

To the extent that the indices constructed are valid, three results emerge: First, regulatory measures on migration are a statistically significant determinant of the probability of choosing a particular destination country. The unexpected direction of the effect, however, suggests that a more complex relationship may exist between migration barriers, rents to certain professions, and the choice of destination of would-be migrant professionals. This is an aspect that deserves further study. Second, in line with the results of other studies, we show that occupational licensing does indeed inhibit the geographical mobility of professionals. Finally, distance—interpreted as a proxy for travel cost or even cultural dissociation—does not appear to play a large role in professionals' choice among destinations. Instead one cannot rule out that career- and profession-specific prospects carry more weight in such decisions.

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Annex. The dataset for the nested logit model

The Labor Force Survey (LFS) and the Survey of Overseas Filipinos (SOF) were received separately. It was the task of this researcher to combine the two datasets. Since the chosen profession was engineering, all the individuals in both datasets that reported engineering as their primary occupation (in the case of the LFS) or occupation abroad (in the case of the SOF) were identified.

The two datasets were concatenated, or, in this case, joined at the bottom. Recall that the LFS asks the question whether a household member was an overseas worker or not. If the response was an affirmative, the rest of the LFS questionnaire was left unanswered for that household member. Thus, the only pieces of information there is for that household member are the household identifier variables and the demographic characteristics such as sex, age, relationship to household head, civil status and highest educational attainment. The LFS sub-sample was pared down to include only those who stayed in the Philippines. All those who answered yes to the question on overseas workers were dropped.

No information is deemed lost from dropping these observations since the same set of information is made available in the SOF. Information about the overseas worker is considered to be more reliable if coming from the SOF. At the same time, the SOF captures a broader set of overseas Filipinos beyond the overseas workers. Finally, even if the information from the LFS were kept, there would not have been any information on the country of destination on the observations unique to the LFS and, therefore, these observations would have been dropped during estimation.

As a result, there are 2,773 engineers from the pooled set of the LFS for 1995 until 2001. The number of overseas engineers used in the conditional logit estimation is 135 or 4.9 percent of engineers in the LFS.