

On the Concept of Immigrants Health-Economic Integration in the United States: The role of English Language Proficiency

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Abstract

This paper investigates the role of English language proficiency (ELP) as a measure of cultural integration on U.S. immigrant families' economic integration, as measured by annual earnings, and health care market integration, as captured by annual medical care spending. Bayesian Markov Chain Monte Carlo (MCMC) estimation of a mixed bivariate ordered probit (MBOP) model of annual earnings and medical care spending is conducted using a nationally representative pooled cross-sectional sample data from three waves of the U.S. National Health Interview Surveys (NHIS). The results reveal that limited English proficiency is associated with lower marginal earnings propensities (-\$44.83, -\$50.66, and -\$56.97), and higher marginal medical care spending propensities (\$8.09, \$6.09, and \$4.32) for each of three decreasing levels of ELP. Furthermore, we find a small yet statistically significant positive 7.2% correlation between immigrant families' annual earnings and medical care spending propensities in post-ACA-USA. Therefore investing to raise immigrants' families ELP in the U.S. would not only contribute to more effective socio-economic integration, but also strengthen the U.S. workforce and economy for decades to come.

JEL classification: I12, I31, J15, J31, J61, F22, Z13

Key words: English proficiency, Earnings, Immigrants, MCMC, Medical Care Spending

1. Introduction

According to the UN's International Organization, for Migration (IOM) the world is facing the highest levels of forced displacement recorded since World War II, with a dramatic increase in the number of refugees, asylum seekers and internally displaced people across various regions of the world. There are an estimated 244 million international migrants (3.3% of the world's population), an increase from 155 million in 2000 (The Lancet Public Health, 2018). As a response, on May 17–19, 2018 over 700 participants from 50 countries met and signed as “The Edinburgh Declaration (ED)¹” during the first World Congress on Migration, Ethnicity, Race and Health. The landmark global consensus reached by the signees of the ED establishes a commitment to respond to the challenges and opportunities that migration and diversity presents for health and well-being. Although characterized by global commitments, including the 2030 Agenda for Sustainable Development, the second 15 years cycle of the 21st century is expected to experience a growing wave of electoral support for nationalism and populism², especially in regards to immigration. Whether past trends in immigrants' socio-economic integration in most developed host nations will continue is unclear (Batalova et al., 2018; Pierce et al., 2018).

In the U.S. for example, immigrants³, also referred to as “foreign born,” make up a large and increasing share of the population. In 2015, U.S. Census Bureau estimates an immigrant population of approximately 43.3 million, which is 13.5 percent of the total population of 321.4 million. Immigrants to the U.S. come from more than 100 different countries (Camarota, 2012). The majority of recent migrants come from Latin America and Asia, The top ten countries of origin account for 60% of U.S. immigration⁴. With U.S. fertility rates at a historic low, the Census Bureau projects that net international migration will be the main driver of U.S. population growth between 2027 and 2038 (Batalova and Alperin, 2018).

Present-day immigration in the U.S. is further characterized by a greater variation in immigrants' geographic distribution across the country. In 1990, 73% of immigrants resided in the traditional gateway states, compared to 27% living in all other states. By 2014, the proportion living in traditional gateway states declined to 64%, compared to 36% of immigrants living in nontraditional immigration states (Camarota and Zeigler, 2016). As shown in figure (1), U.S. immigrant population grew by 15% or more in 15 states, with an overall national average of 9% (Batalova and Alperin, 2018). Moreover, contemporary immigrants show greater diversity with regard to their formal immigration status, which can be categorized into three broad groups (Kandell, 2011): (i) legal immigrants, including naturalized citizens and lawful

¹ For more information, see <http://www.merhcongress.com/welcome/edinburgh-declaration/>.

² Although the policies vary from country to country, they all share a number of characteristics: a sense of exclusive nationalism, belief that national identity is under threat from foreign cultures, desire to sharply cut immigration, and distrust of elites (Shain, 2018).

³ Defined by the U.S. Census Bureau as individuals who do not have U.S. citizenship at birth, including naturalized citizens, lawful permanent residents, certain legal nonimmigrants (e.g., individuals on student or work visas), those admitted under refugee or asylum status, and individuals illegally residing in the United States and their native born child (2nd generation).

⁴ Mexico (26.9 %), India (5.5 %), China (4.8 %) and Philippines (4.6 %), El Salvador (3.1 %), Vietnam (3.0 percent), Cuba (2.8 percent), and Korea (2.4 percent), as well as the Dominican Republic (2.5 percent) and Guatemala (2.1 percent).

(permanent/ temporary) residents; (ii) refugee (and asylums); (iii) illegal (undocumented) immigrants.

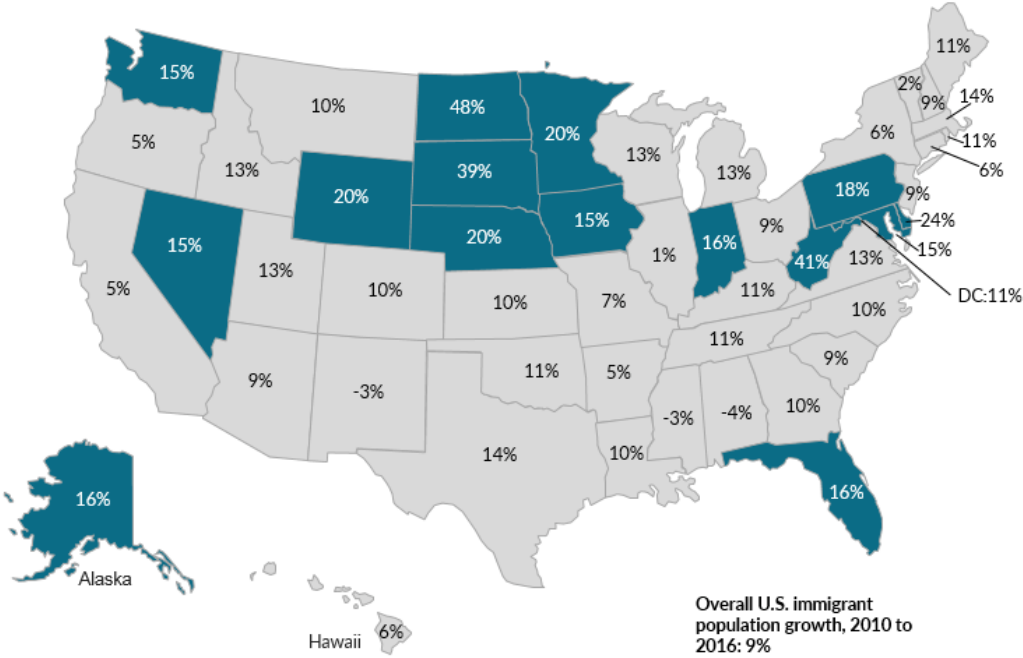


Figure 1: Percentage change in immigrant population by States 2010-2016 (Source: Migration Policy Institute (MPI) using U.S. Census Bureau data from the 2010 and 2016 from the American Community Survey).

Despite this diversity, U.S. immigrants experience an assimilation process through which they learn and adapt to U.S. laws, norms, values, and language (Borjas, 2007). In addition to immigrant well-being, various economic impacts of assimilation have received attention from scholars and policy makers, including immigrant effects on fiscal health of the jurisdictions in which they reside and on direct effects on the native workforce (Terrazas, 2011; Shain, 2018). Economists have relied on a narrower definition than scholars from other fields based on earnings and wages (Xie and Gough, 2011). This concept has also been extended to include a disparity in welfare use (Xu and Kalina, 2012), where welfare utilization may indicate the extent of immigrants’ economic hardships.

The labor market has been the most important institution for the economic and social integration of immigrants in the U.S. (Terrazas, 2011), where employment is used as a primary indicator (Camarota, 2012; Capps et al., 2013). Recent national estimates (Camarota and Zeigler, 2016) suggest that contemporary immigrants are well integrated into the U.S. labor market, compared to past immigrants and immigrants to other developed countries. Looking at job quality however, this later study found that immigrants are mainly concentrated in lower skilled service and industrial occupations, compared to their native counterparts. Accordingly, immigrants have relatively lower earnings. In 2015 for example, the per-capita median household income of immigrant-headed households (\$16,025), lagged behind that of native-headed households (\$22,941) (Current Population Survey; ASEC Supplement, 2015). In 2016, about 16% of immigrant families had an annual income below the federal poverty line,

compared to 12-14 percent among the U.S. born (Batalova et al., 2018), suggesting that members of immigrant households are more vulnerable to economic hardship.

Because of this vulnerability, immigrant families are relatively more likely than their native counterparts to live in poverty and rely on welfare programs. For example, in examining an extensive list of welfare programs, including Temporary Assistance to Needy Families (TANF), state administered general assistance (GA), Supplemental Security Income (SSI), Supplemental Nutrition Assistance Program (SNAP), free and subsidized school lunch, Women, Infants, and Children nutrition program (WIC), subsidized and government-owned housing, and Medicaid, Camarota and Zeigler (2016) showed that current immigrants are more likely to use public assistance than natives.

As laws are drafted limiting illegal immigrants access to public programs (Batalova et al., 2018), these families will likely be more vulnerable and at elevated risk for other social problems (Castañeda et al., 2015). This may affect or be affected by their unsuccessful economic integration. Indeed Pierce et al. (2018) reports a significant behavioral adjustment in the U.S. immigrants' population including a sharp decrease in crime reporting (e.g. domestic violence); fewer applications for public benefits to which immigrants and their U.S.-born children are entitled; and rising no-shows at health care appointments. The consequences of which include poor physical health (heart disease, high blood pressure, diabetes) (Blanas et al., 2013 ; Carten et al., 2013 ; Hoffman et al., 2011), and elevated risk of mental health problems including depression and anxiety (Batalova et al., 2018; Chung, 2012; Jurcik et al., 2013; Leung et al., 2012).

Among the most important factors, affecting immigrants' households' vulnerability to health and labor market hardship is the lack of "country specific human capital" such as English language proficiency (ELP)⁵ for new settlers (Divi et al., 2007; Kim et al., 2011). In fact, ELP could affect immigrants' health and labor market outcomes through several potential channels (Sentell and Braun, 2012). Theoretically, Grossman's (1972) model of health production identifies a twofold role of language skills: it directly affects the efficiency of health production and indirectly affects access to health inputs. The empirical evidence in several parts of world also suggests that proficiency in the primary spoken language in the location in which one lives improves one's earnings potential through favorable employment outcomes, resulting in more investment in one's health (Duncan and Mavisakalyan 2015) in Russia, (Chiswick and Miller, 2010) in the U.S., and (Güven & Islam, 2015; Clarke and Ispording, 2017) in Australia. In a more comprehensive report, Chiswick and Miller (2015) also arrive at the same conclusion for immigrants in the U.S., Canada, Australia, the UK, Germany, Israel and Spain.

Although the theoretical and empirical evidence support a significant relationship between health and labor market outcomes, the existing literature is silent about the impact of language proficiency on the joint outcomes of immigrants' labor market earnings and health care spending in the U.S. One stream of literature focuses on how language proficiency affects health care market outcomes (Dillender, 2017; Fernandez et al. 2011; Fryer et al., 2013; Jacobs,

⁵ Limited ELP refers to those who reported speaking English "not at all," "not well," or "well" on the questionnaire. Individuals who reported speaking English exclusively or "very well" are considered proficient in English.

2016; Lebrun et al., 2012; López et al., 2015; Schachter et al. 2012; Schwei et al., 2018; Tegegne, 2018; Zendedel et al., 2018).

The other stream examines its effect on labor market outcomes (Bleakley and Chin, 2010; Budria and Swedberg, 2015; Gentsch and Massey, 2011; Miranda and Zhu, 2013; Schuss, 2018). This study, which follows Shields and Price (2002), Chiswick and Miller (2010), and Elsayed and DeGrip (2018), brings these two aspects of immigrants’ integration together, and describes the welfare implications of immigrants English language proficiency in the U.S. More specifically, it introduces the concept of “*immigrants’ health-economic integration*”⁶, and investigates the health care market and labor market outcomes of immigrants with various levels of English language proficiency. The general question it seeks to address is:

How does English language proficiency affect immigrant families’ health care market and labor market integration in post-ACA- USA?

More specifically,

- (i) *Q1: How does English language proficiency affect immigrant families’ annual earnings and Medical care spending in post-ACA- USA?*
- (ii) *Q2: What relationship exists between immigrant families’ annual earnings and medical care spending in post-ACA-USA?*

Based on the above-discussed theoretical and empirical evidence, we formulate the following hypothesis in relation to our two specific questions

- (i) *H01: English language proficiency increases immigrant families’ earnings in post-ACA-USA [see figure (2) arrow (1)]*
- (ii) *H02: English language proficiency reduces immigrant families’ medical care spending in post-ACA-USA [see figure (2) arrow (2)]*
- (iii) *H03: There is a significant positive relationship between immigrant families’ annual earnings and medical care spending in post-ACA-USA [see figure (2) arrow (3)]*

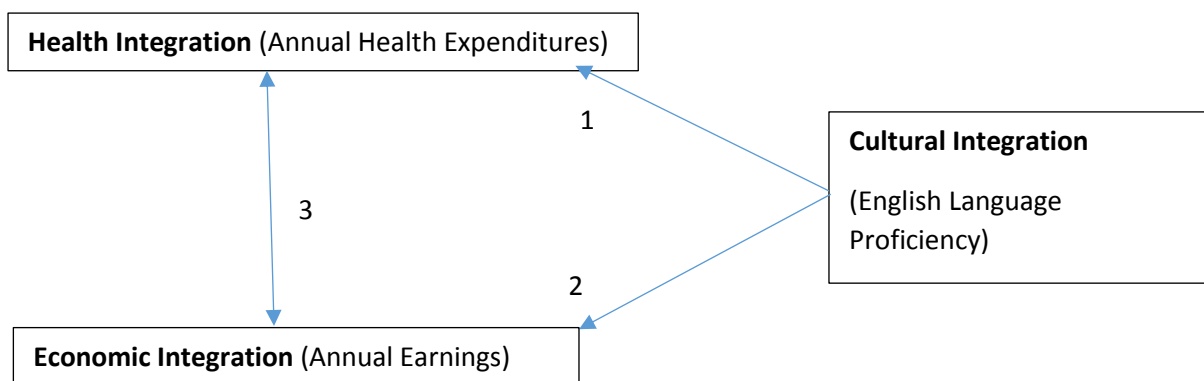


Figure 2: *The Conceptual Framework of the effect of ELP on Health-Economic Integration*

⁶ Immigrants health-economic integration/inclusion can be described as a policy goal for governments, directed at eliminating the exclusion of all immigrants to enable everyone (immigrants and native alike) "to have access to, use, participate in, benefit from and feel a sense of belonging to both the health care market and the labor market of the host country".

In order to test the above hypotheses and provide answers to the raised questions, we rely on a Generalized Linear Mixed Modelling of the Bivariate ordered Probit model of Earnings and Medical Expenditure, which is then estimated Using Bayesian Markov Chain Monte Carlo Methods.

In doing so, the contribution of this paper is two folds:

- It provides the most up to date treatment of the topic using a nationally representative sample of the U.S. immigrant population
- Methodological: through the joint bivariate representation of the integration process, and subsequent use of MCMC methods for parameter identification.

The rest of the paper is organized as follows. Section 2 reviews the literature on language proficiency and immigrants' welfare as measured by health and labor market outcomes. Section 3 describes the methodology followed to test the hypothesis. Section 4 presents and discusses the findings, while section 6 concludes the analysis and provide recommendations.

2. Literature review

Our review of the literature on language proficiency and immigrant welfare is organized in two main streams: (i) language proficiency and immigrant health care market integration, and (ii) language proficiency and immigrant labor market integration. Before reviewing these two streams of literature, the concept of immigrants' integration is discussed.

2.1 Concept(s) of immigrants integration

The concept of *integration*, in its usage pertaining to immigration, is open to a range of definitions, which undergo particularly significant variations between different national contexts (Rudiger and Spencer, 2003). In the broadest sense, integration means the process by which people who are relatively new to a country become part of society (Duman, 2018). In view of a tendency to conceive integration as a one-way assimilation, this concept is being replaced with other terms such as "inclusion," which has the advantage of providing a better link to policy concerns, since policymakers use it to refer to all social groups, not just immigrants (Kogan et al., 2018). The debates around the usage of the term "integration" indicate that it is a highly normative concept. As a policy objective, integration implies an assumption about a desirable social order, with a high degree of internal cohesion, making it attractive to policymakers, who aim for stability (Elsayed and De Grip, 2018).

If integration is measured in relation to an existing social order with its hegemonic practices and values, then its focus will always be on immigrants' adaptation rather than steps that may be necessary to facilitate their inclusion and participation (Rudiger and Spencer, 2003). This means that immigrants' integration failure can be the result of a resistance to change on part of the host society. This could further mean for example that an immigrant can be excluded from receiving preventive health care, or accessing employment, because health services are only provided, or employment tasks are only performed in the main national language (English) (Bousmah et al., 2018). While it is crucial that immigrants take an active role in the integration process, this is only possible when existing structures are not so rigid to allow it (Duman, 2018). In pluralist democracies, such change should not be perceived as a threat to stability but as part of the flexibility and openness of the society, which is constantly

developing, striving for greater equality and more opportunities for all members (Elsayed and De Grip, 2018). In such context, immigrants' health-economic integration/inclusion can be described as a policy goal for governments, to eliminate immigrants' exclusions from the health care market and the labor market of the host country.

2.2 Language proficiency and immigrants' health care market integration

Jacobs, et al. (2006) stressed the need for more research on language barriers in health care. Since this seminal paper, many others have pursued this agenda (e.g., Dillender, 2017; Fryer et al., 2013; Jacobs, 2016; López et al., 2015; Schwei et al., 2018). For example Mui et al. (2007), and Gee and Ponce (2010) found that English Language Proficiency (ELP) has a direct impact on health related quality of life. ELP is also reported to enhance immigrants' health status, access to primary and preventive health care (Salinas and Sheffield, 2011), enrollment in health insurance programs (Lebrun 2012; Schachter et al. 2012; Dillender, 2017), adherence with medical advice (Andreae et al., 2016) and satisfaction with medical treatment (Fernandez et al. 2011). U.S. Immigrants with limited ELP tend to have a poorer understanding of their illness, lack understanding of the treatment that they receive (González et al. 2010; Wilson et al., 2005) and are less likely to follow treatment instructions and physician's recommendations or to pay follow-up health visits (Clark et al. 2004). Limited ELP inhibits both patients' ability to accurately express symptoms and physicians' ability to diagnose (Divi et al. 2007). Thus, immigrants with limited ELP are more likely to rely on interpreters (Fryer et al., 2013; Schwei et al., 2018), which sometimes occurs in an informal setting (Zendedel et al., 2018), with potential misinterpretations (Nápoles et al., 2015; Squires and Jacobs, 2016), leading to unnecessary diagnostic testing and hospital admissions (John-Baptiste et al. 2004), increased risk of inappropriate treatment and potential for misdiagnosis (Cheng et al., 2007; López et al., 2015).

2.3 Language proficiency and immigrants labor market integration

Theoretically, much of the empirical economic literature on language proficiency and immigrants' labor market outcomes have relied on human capital theory (Becker, 1962). In this context, the concept of human capital has been used to describe the language skills and experiences that may help immigrants' economic integration (including labor market participation and earning) (Bishop, 1994; Borjas, 2005; Budria and Swedberg, 2015). For example, Chiswick and Miller (2015) shows that immigrants have a weaker economic position at arrival than that of their native counterparts. Mainly because of low "country specific" human capital (Miranda and Zhu, 2013), including English language proficiency (Funkhouser, 2000; Schuss, 2018). According to Sanders and Nee (1996), increased ELP helps an immigrant access information and social contacts, allowing one to build more cultural knowledge, and adjust more easily to the new host country labor market. For example, Bates (1994) found that Asian immigrant-owned small businesses have more success due to owners' investment in human capital including ELP, which Chiswick and Miller (2015) believes is a form of host country specific human capital that may improve one's economic integration in terms of employment and/or higher wages. This assumption has been supported in earlier studies on the impact of immigrants' ELP on earnings (Bleakley and Chin, 2010; Kossoudji, 1988), and further confirmed by Chiswick and Miller (2010). Moreover, Shield and Price (2002), Pfeffer and Parra

(2009), and Gentsch and Massey, (2011) also found increased ELP to improve employment conditions and job tenure for Mexican immigrant workers.

3 Methodology

The theoretical (Becker, 1962; Grossman, 1972) and empirical (Brunello et al. 2016) bidirectional relationship between labor market and health care market outcomes. Therefore, a model of how ELP affects health care must take into account the endogeneity of annual earnings. Ignoring this endogeneity biases the estimated effects of language proficiency and other relevant covariates including annual earnings.

Several methods could be used to accommodate this type of endogeneity, including instrumental variable methods (Angrist et al., 1996) and endogenous switching regressions (Lee and Porter, 1984). Due to the difficulty associated with finding suitable instruments (Bound et al., 1995), and the qualitative ordinal nature of our measured health care market (annual expenditures) and labor market (annual earnings) outcomes, we rely on the switching regression framework following (Lee and Porter, 1984, Niankara, 2018b). Doing so requires the process generating the observed annual earnings to be jointly modelled with the process generating the observed annual health expenditures, while looking at the causal influence of English language proficiency on both. This representation allows the error terms from these two processes to correlate thereby resolving the observed endogeneity issue (Niankara, 2016). Since both annual earnings and annual medical expenditures are measured on a qualitative ordinal scale, the resulting model will be bivariate ordered as described next.

3.1 The Bivariate Ordered Probit (BOP)

We rely on a generalized linear mixed model representation of the BOP. For this we define

H_i : The observed health care market outcome for respondent i (Family medical expenditures)

L_i : The observed labor market outcome for respondent i (Family earnings)

H_i^* : The latent propensity to spend on medical care annually for respondent i family

L_i^* : The latent propensity to earn annually for respondent i family

Following Sajaia's (2008) BOP model representation, we assume that an immigrant family latent propensity to earn annually L_i^* and latent propensity to spend on medical care annually H_i^* are determined by the following system of linear equations:

$$\begin{aligned} L_i^* &= X'_{1i}\beta_1 + Z'_{1i}u_1 + \epsilon_{1i} \\ H_i^* &= X'_{2i}\beta_2 + Z'_{2i}u_2 + \epsilon_{2i} \end{aligned} \tag{1}$$

Where X'_{1i} and X'_{2i} represent the fixed effects vectors of explanatory variables in each equation respectively, and include our primary variable of interest, English language proficiency (ENGLANG2), along with health (HICOSTR2, PHSTAT2, FSA2, ExtendCov2, MEDBPAY), socio-demographic (AGE_P, EDUC1, MaritStat, SEX, CITIZENP) and economic control factors (WRKHRS2). β_1 and β_2 are the corresponding vectors of unknown fixed effects to be estimated. Z'_{1i} and Z'_{2i} represent the random effects vectors of explanatory variables in each equation respectively, and include the indicators of regional variations (REGION2), and annual

variations (SURVY_R) in U.S. immigrant families annual earnings and medical care spending propensities. u_1 and u_2 are the corresponding unknown random effects to be estimated. ϵ_{1i} and ϵ_{2i} are the error terms of the system, and i denotes the individual respondent's subscript. Conditional on Z'_{1i} and Z'_{2i} the fixed effects are assumed to be exogenous, that is

$$E(X'_{1i} \epsilon_{1i} | Z'_{1i}) = E(X'_{2i} \epsilon_{2i} | Z'_{2i}) = 0.$$

The observed family annual earning L_i and medical care spending H_i are related to the corresponding latent propensities to earn L_i^* and spend on medical care H_i^* as follows:

$$L_i = \begin{cases} 1 \text{ or } [\$0 - \$34,99] & \text{if } L_i^* \leq \mu_1 \\ 2 \text{ or } [\$35,000 - \$64,999] & \text{if } \mu_1 \leq L_i^* \leq \mu_2 \\ 3 \text{ or } [\$65,000 \text{ and more}] & \text{if } \mu_2 < L_i^* \end{cases} \quad (2)$$

$$H_i = \begin{cases} 1 \text{ or } [\$0 - \$499] & \text{if } H_i^* \leq \delta_1 \\ 2 \text{ or } [\$500 - \$1,99] & \text{if } \delta_1 \leq H_i^* \leq \delta_2 \\ 3 \text{ or } [\$2,000 \text{ and more}] & \text{if } \delta_2 < H_i^* \end{cases} \quad (3)$$

Where the unknown cut-offs satisfy the condition that $\mu_1 < \mu_2$ and $\delta_1 < \delta_2$. For identification purposes, the first threshold values are “anchored” a priori, such that $\mu_1 = \delta_1 = 0$. Following McKelvey and Zavoina (1975) recommendations, we also set $\mu_0 = \delta_0 = -\infty$ and $\mu_3 = \delta_3 = +\infty$ in order to avoid handling boundary cases separately. As such, the probability of $L_i = j$ and $H_i = k$ is:

$$\begin{aligned} \Pr(L_i = j, H_i = k) &= \Pr(\mu_{j-1} \leq L_i^* \leq \mu_j, \delta_{k-1} \leq H_i^* \leq \delta_k) \\ &= \Pr(L_i^* \leq \mu_j, H_i^* \leq \delta_k) \\ &\quad - \Pr(L_i^* \leq \mu_{j-1}, H_i^* \leq \delta_k) \\ &\quad - \Pr(L_i^* \leq \mu_j, H_i^* \leq \delta_{k-1}) \\ &\quad + \Pr(L_i^* \leq \mu_{j-1}, H_i^* \leq \delta_{k-1}) \end{aligned} \quad (4)$$

If we assume ϵ_{1i} and ϵ_{2i} to have a joint bivariate normal distribution, with correlation ρ then the individual contribution of a respondent i to the likelihood function can be expressed as:

$$\begin{aligned} \Pr(L_i = j, H_i = k) &= \Phi_2(\mu_j - X'_{1i}\beta_1 - Z'_{1i}u_1, (\delta_k - X'_{2i}\beta_2 - Z'_{2i}u_2)\zeta, \tilde{\rho}) \\ &\quad - \Phi_2(\mu_{j-1} - X'_{1i}\beta_1 - Z'_{1i}u_1, (\delta_k - X'_{2i}\beta_2 - Z'_{2i}u_2)\zeta, \tilde{\rho}) \\ &\quad - \Phi_2(\mu_j - X'_{1i}\beta_1 - Z'_{1i}u_1, (\delta_{k-1} - X'_{2i}\beta_2 - Z'_{2i}u_2)\zeta, \tilde{\rho}) \\ &\quad + \Phi_2(\mu_{j-1} - X'_{1i}\beta_1 - Z'_{1i}u_1, (\delta_{k-1} - X'_{2i}\beta_2 - Z'_{2i}u_2)\zeta, \tilde{\rho}) \end{aligned} \quad (5)$$

Where Φ_2 is the bivariate standard normal cumulative distribution, $\zeta = \frac{1}{\sqrt{1+2\gamma\rho+\gamma^2}}$ and $\tilde{\rho} = \zeta(\gamma + \rho)$. Next, we describe the estimation strategy used to uncover the parameters of the model.

3.2 Estimation Strategies

Estimation of the above-described generalized linear representation of the bivariate ordered probit model can be done using maximum simulated likelihood methods (Lee, 1992) or Bayesian Markov Chain Monte Carlo (MCMC) methods (Zhao et al., 2006). Because of the multidimensionality of the choice probabilities, and the intractability in integrating over the random effects (McCulloch and Searle, 2001), we employ a Bayesian MCMC methods following (Browne and Draper, 2006; Niankara 2018a)

3.2.1 The Bayesian MCMC framework

Because the bivariate ordered probit (BOP) model as represented in equation (1) is a special case of the more general class of Generalized Linear Mixed Models (GLMMs) with a specified probit link function for each outcome variable, we follow the standard multivariate notation for GLMMs (Hadfield, 2010). This is obtained by stacking the vectors of immigrant families' latent propensities to earn L_i^* and spend on medical care H_i^* into a single column vector across all N responding families in the sample. In this form, we obtain a $(2) \times (N)$ dimensional latent vector ($\mathbf{Y}^* = [L_i^*, H_i^*]$) for the whole sample of respondents:

$$\mathbf{Y}^* = \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}\mathbf{u} + \mathbf{e} \quad (6)$$

Where \mathbf{X} is a design matrix relating the fixed predictors to the data, and \mathbf{Z} is a design matrix relating random predictors to the data. These predictors have associated parameter vector $\boldsymbol{\beta} \sim N(\boldsymbol{\beta}_0, \mathbf{B})$, and $\mathbf{u} \sim N(\mathbf{0}, \mathbf{G})$. The residuals vector is represented by $\mathbf{e} \sim N(\mathbf{0}, \mathbf{R})$. In this formulation \mathbf{B} , \mathbf{G} and \mathbf{R} are the expected (co)variance matrices of the fixed effects, random effects and residuals, respectively. They are typically unknown, and must be estimated from the data. Since no distinction is made between fixed and random effects in a Bayesian analysis, as all effects are considered random, we can combine the design matrices ($\mathbf{W} = [\mathbf{X}, \mathbf{Z}]$) and the parameters ($\boldsymbol{\theta} = [\boldsymbol{\beta}', \mathbf{u}']$), to rewrite equation (6) as

$$\mathbf{Y}^* = \mathbf{W}\boldsymbol{\theta} + \mathbf{e} \quad (7)$$

The prior distribution for the location effects $\boldsymbol{\theta}$ is multivariate normal, with the zero off diagonal implying a priory independence between fixed effects and random effects

$$\boldsymbol{\theta} = \begin{bmatrix} \boldsymbol{\beta} \\ \mathbf{u} \end{bmatrix} \sim N \left(\begin{bmatrix} \boldsymbol{\beta}_0 \\ \mathbf{0} \end{bmatrix}, \begin{bmatrix} \mathbf{B} & \mathbf{0} \\ \mathbf{0} & \mathbf{G} \end{bmatrix} \right) \quad (8)$$

The goal of the analysis is to estimate $\boldsymbol{\theta}$. The prior for $\boldsymbol{\theta}$ can be Gibbs sampled in a single block using the method of Gracia-Cortes and Sorensen (2001) as explained below. With conjugate priors, the variance structures (\mathbf{R} and \mathbf{G}) follow an inverse-Wishart distribution, which is also Gibbs sampled in a single block. The explicit representation of the \mathbf{G} structure is as follows:

$$\mathbf{G} = \begin{bmatrix} \mathbf{V}_1 \otimes \mathbf{A}_1 & \mathbf{0} \\ \mathbf{0} & \mathbf{V}_2 \otimes \mathbf{A}_2 \end{bmatrix} \quad (9)$$

Where the zeros off diagonal represent the independence between component terms, and (\otimes) is the Kronecker product allowing for the dependence between random effects within each component term. $\mathbf{V}_1 \otimes \mathbf{A}_1$ is the expected (co)variance matrix capturing the variations in the measurements of the two outcomes (Earnings, Medical care spending) across the four U.S. census regions, while $\mathbf{V}_2 \otimes \mathbf{A}_2$ is the expected (co)variance matrix capturing the variations in the measurements of Earnings and medical care spending across the three survey years. The (co)variance matrices (\mathbf{V}) are low dimensional and estimated, while the structured matrices (\mathbf{A}) are high dimensional and treated as known. The effects of the independent random components are additive (\oplus), such that equation (9) is equivalently represented as:

$$\mathbf{G} = (\mathbf{V}_1 \otimes \mathbf{A}_1) \oplus (\mathbf{V}_2 \otimes \mathbf{A}_2) \quad (10)$$

Accounting for these two sources of systematic random variations (regional, and annual) in the measurements of the two outcomes, all remaining variations in earnings and medical care spending are assumed to be idiosyncratic, and thus captured by the residual (co)variance \mathbf{R} .

3.2.2 Updating the latent utilities

For a given individual, the conditional density of the multidimensional latent vector Y_i^* is given by:

$$P(Y_i^* | \mathbf{y}, \boldsymbol{\theta}, \mathbf{R}, \mathbf{G}) \propto f_i(y_i | Y_i^*) f_N(\mathbf{e}_i | \mathbf{r}_i \mathbf{R}_{/i}^{-1} \mathbf{e}_{/i}, r_i - \mathbf{r}_i \mathbf{R}_{/i}^{-1} \mathbf{r}'_i) \quad (11)$$

Where f_N represents the multivariate normal distribution with specified mean vector and (co)variance matrix. Hence, equation (11) suggests that the conditional density of the latent vector for individual i is proportional to the product of the conditional distribution of the joint outcome y_i given the latent vector Y_i^* , and the joint probability density of the utility residuals. The multidimensional vector of residuals \mathbf{e}_i for individual i follows a conditional normal distribution, where the conditioning is on the residuals associated with the other ($N-1$) individuals in the sample. The notation $/i$ denotes vectors or matrices with the i^{th} row and or column removed. This conditioning accounts for residual correlation across individuals. Latent propensities are updated in blocks of correlated residuals. This is achieved through block sampling, where a block is a group of residuals expected to be correlated in equation (7), such that equation (11) can be rewritten as:

$$P(y_k^* | \mathbf{y}, \boldsymbol{\theta}, \mathbf{R}, \mathbf{G}) \propto p_i(y_i | y_k^*) f_N(\mathbf{e}_k | \mathbf{0}, \mathbf{e}_k) \quad (12)$$

Where k indexes a block of correlated latent earnings and medical care spending propensities, which have non-zero residual covariance. Because residuals are correlated across outcomes and individuals, we have a total of $(N) \times (2)$ residual correlations, with $k = 1$. Therefore the conditional density of each latent propensity y_{it}^* for all $i = 1 \cdot \cdot \cdot N$, and $t = 1, 2$ is obtained by conditioning each e_{it} on the remaining $[1 + (N - 1) \times 2]$ residuals.

Following Haario et al. (2001), the average posterior (co)variance matrix \mathbf{M} of the single block $(2) \times (N)$ dimensional vector y_k^* with $k = 1$ is updated at each iteration of the burn-in. An efficient multivariate proposal density with covariance matrix $v\mathbf{M}$ is

determined using adaptive methods during the burn-in phase. The scalar v is obtained using the method of Ovaskainen et al. (2008) so that the proportion of successful jumps in the Markov Chain is optimal at a rate of 0.23 (Gelman et al., 2004).

3.2.3 Updating the location vector

The location vector ($\boldsymbol{\theta} = [\boldsymbol{\beta}', \mathbf{u}']$) is sampled as a block using a method by Gracia-Cortes and Sorensen (2001) which involves solving the sparse linear system:

$$\tilde{\boldsymbol{\theta}} = \mathbf{C}^{-1} \mathbf{W}' \mathbf{R}^{-1} (\mathbf{Y}^* - \mathbf{W} \boldsymbol{\theta}_* - \mathbf{e}_*) \quad (13)$$

This system is solved using cholesky factorization from the sparse library in R by Davis (2006). \mathbf{C} is a sparse matrix (populated primarily with zeros) representing the model coefficient matrix:

$$\mathbf{C} = \mathbf{W}' \mathbf{R}^{-1} \mathbf{W} + \begin{bmatrix} \mathbf{B}^{-1} & \mathbf{0} \\ \mathbf{0} & \mathbf{G}^{-1} \end{bmatrix} \quad (14)$$

$\boldsymbol{\theta}_* = [\boldsymbol{\beta}'_*, \mathbf{u}'_*]$ and \mathbf{e}_* are random draws from the multivariate normal distributions:

$$\begin{bmatrix} \boldsymbol{\beta}_* \\ \mathbf{u}_* \end{bmatrix} \sim N \left(\begin{bmatrix} \boldsymbol{\beta}_0 \\ \mathbf{0} \end{bmatrix}, \begin{bmatrix} \mathbf{B} & \mathbf{0} \\ \mathbf{0} & \mathbf{G} \end{bmatrix} \right) \quad (15)$$

And

$$\mathbf{e}_* \sim N(\mathbf{W} \boldsymbol{\theta}_*, \mathbf{R}) \quad (16)$$

A realization from the required probability distribution $P(\boldsymbol{\theta} | \mathbf{Y}^*, \mathbf{W}, \mathbf{R}, \mathbf{G})$ is then $\tilde{\boldsymbol{\theta}} + \boldsymbol{\theta}_*$

3.2.4 Updating the variance structures \mathbf{G} and \mathbf{R}

All information for the estimation of the residual structure \mathbf{R} comes from the inverse-Wishart prior distribution, following a conditional sampling strategy provided by Korsgaard et al. (1999). For the \mathbf{G} structure, the sum of squares matrix associated with each of the three random components has the form:

$$\mathbf{S} = \boldsymbol{\phi}' \mathbf{A}^{-1} \boldsymbol{\phi} \quad (17)$$

Where $\boldsymbol{\phi}$ is a matrix of random effects with each row indexing the relevant row/column of \mathbf{A} , and each column indexing the relevant row/column in \mathbf{V} , and also \mathbf{A} and \mathbf{V} defined as in equations (9) and (10). The parameter (co)variance matrix is then sampled from the inverse-Wishart distribution:

$$\mathbf{V} \sim \mathbf{IW} \left((\mathbf{S}_p + \mathbf{S})^{-1}, n_p + n \right) \quad (18)$$

Where \mathbf{S}_p and n_p are the prior sum of squares and prior degrees of freedom, respectively, and n is the number of rows in the matrix of random effects $\boldsymbol{\phi}$.

3.2.5 Updating the cutoff points

The methods developed by Cowles (1996), are used to allow the cutoff points to be updated simultaneously with the latent propensities of earning and medical care spending, using a Hastings-with-Gibbs update.

3.3 The Data

The data used in this analysis is a pooled cross section of the 2015–2016-2017 NHIS (National Center for Health Statistics and others, 2015, 2016, 2017). Initiated in 1957 by the National Health Survey Act of 1956, the NHIS has been conducted since 1960 by the National Center for Health Statistics (NCHS) (Blackwell et al., 2014). Although redesigned after every decennial census, NHIS is a cross-sectional household, multistage probability sample survey conducted annually by interviewers of the U.S. Census Bureau for the Centers for Disease Control and Prevention’s National Center for Health Statistics. Further details on the current sampling design are found in the NCHS report (Parsons et al., 2014). The target population is the civilian non-institutionalized population residing in the USA at the time of the interview. Niankara (2018b) provides a full description of this survey data.

After variables selection, data treatment and accounting for missing information, the final pooled cross-sectional panel data contains 46,032 observations, 16,028 of which are from the 2015 sample adult component, 16,369 from the 2016 sample adult component, and the remaining 13,635 from the 2017 sample adult component. From this sample of 46,032 we filter to extract the immigrants sample with 6849 observations, distributed as 2741 (2015), 2225 (2016) and 1883 (2017). Table 1 below describes the selected variables in the dataset.

4 Findings

The results are divided into two parts; the first part provides the univariate and bivariate descriptive statistics, while the second part describes the econometric results from the Bayesian MCMC estimation of the BOP model.

4.1 Descriptive results

Focusing on the descriptive statistics for the variables of direct interest in this study as shown in table (1), we note that 40.02% of the adult immigrant respondents in the pooled sample come from the 2015 wave, 32.49% from the 2016 wave, and the remaining 27.49% from the 2017 wave. Of all immigrant respondents in the pooled sample, 63.9% report speaking English very well, 23.3% report speaking well, while the remaining 12.8% report not speaking English well. Furthermore, the majority (37.2%) report earning less than \$35,000, while 31.2% report earning between \$35,000 and \$65,000, and the remaining 31.6% report earning over \$65,000. With respect to family annual care spending, the greater majority of adult immigrant respondents (39.3%) reports spending less than \$500 annually on medical care, followed by 33.2% reporting spending between \$500 and \$2000, while the remaining 27.4% reports spending over \$2000.

In table (2) the descriptive statistics for the socio-demographic qualitative control variables show in the last column that 53.2% of immigrant respondents in the pooled sample are males, while the remaining 46.8% are females. In addition, the racial distribution shows that over half (55.9%) of immigrant respondents are Caucasians, followed by 32.4% Asians, then 10.3% Blacks, and the remaining 1.4% are of other races. Furthermore, the majority (72.6%) are currently married, followed by 16.7% who have never married, and 10.7% who were previously married. Moreover, the greater majority of adult immigrant respondents (65.7%) reports now being U.S. citizens, while the remaining 34.3% are still non-citizens.

Finally, the regional distribution across the four census regions shows that the greatest majority of adult immigrants (35.6%) live in southern states, followed by 34.9% living in western states, then 16.7% living in northwestern states, and finally 12.9% living in the Midwest region.

In the last column of table (3) 48.6% of adult immigrants respondents report having optional insurance to supplement their basic coverage, while the greater majority (51.4%) reports lack coverage. Similarly, 23.4% report paying medical bills overtime, while the greater majority (76.6%) reports not paying over time. Moreover, most (81.9%) report not having a flexible spending account, while the remaining 18.1% report enrollment in such account before their employer. Finally, with respect to physical health conditions, the majority of adult immigrant respondents (36.9%) reports an excellent health status, followed by 33.4% reporting a very good health status, then by 23.9% reporting a good health status, and finally 5.8% reporting a fair or poor health status.

In table (4), which presents the descriptive statistics for the quantitative control variables, we note that the mean time spent working per week has remained stable and over 40 hours/week between 2015 and 2017, with a pooled sample average of 41.42 hours, and a standard deviation of 11.14 hours. In addition, the mean age of adult immigrant respondents has remained stable around 44 years, with a pooled sample average of 44.29 years, and a standard deviation of 11.59 years. Furthermore, the average adult immigrant has over 15 years of education with a standard deviation of 3.85. Finally, the insurance premium figures suggest an increase in average premium costs from \$3791 (2015), to \$4018 (2016), and ending with \$4112 (2017); for a pooled sample average of \$3973, and a standard deviation of \$3519.

In order to understand the unconditional relationships between ELP, annual earnings and medical care spending, we also perform the chi-square test of independence between the three dimensions of immigrants integrations, with the results summarized in table (5). In fact, a statistically significant relationship is found between ELP and annual medical expenditures, between ELP and annual earnings, but also between annual earnings and medical expenditures. This is seen from the respective chi-squared test statistics in table (5), along with the p-values less than the 5% significance level. As such, we proceed to summarize the unadjusted conditional distributions of the three dimensions of immigrants' integration in table (6).

4.2 Econometric results

The presentation of the econometric results is divided into three sub-sections; the first one focuses on describing the direct effects of ELP on immigrant families' annual earnings and medical care spending propensities, but also describes the nature of the relationship between the two outcome variables. The second sub-section focuses on describing the effects of the control variables on immigrant families' earnings propensity, while the last sub-section focuses on describing the effects of the control variables on immigrant families' medical care spending propensity.

For our MCMC estimation, we defined 100,000 iterations of the algorithm with a burn-in period of 15,000 iterations, and a thinning interval of 10 iterations. This has led to an effective sample size of 8500 Markov draws, which were then used to estimate the parameters of the model, along with their 95% confidence intervals (CI). In addition to the fixed parameters

described in equation (8), and the cutoff points described in section (3.2.5), the algorithm estimates the **G**-structure for the random effects as described in equation (9). Here it includes the observed sampling errors across census regions (south, northwest, Midwest, west), and the sampling errors across survey years (2015, 2016, 2017) in the two measured outcomes (annual earnings and medical care spending). After accounting for these two sources of variations, all remaining variations in annual earnings and medical care spending are idiosyncratic, and described by the residual variance-covariance matrix (**R**-structure).

4.2.1 Random effects, residuals and cutoff points estimates

The results of the random effects variance (**G**) are summarized in table (7), and show statistically significant posterior mean sampling errors across U.S. census regions of 1.71 (with 95% CI [2.18e-17; 6.41]), and 7.82 (with 95% CI [8.30e-06; 26.75]) for respectively annual medical care spending and annual earnings. Similarly, the estimated posterior mean sampling errors across survey years are found to be 0.11 (with 95% CI [2.20e-17; 0.07]), and 21.56 (with 95% CI [4.02e-17; 40.78]) for annual medical care spending and annual earnings, respectively.

The results of the estimated residual variance-covariance matrix (**R**) is summarized in table (8). The table shows a variance of 403.72 (with 95% CI [3.96; 851.94]) for immigrant families annual medical care spending, a variance of 474.22 (with 95% CI [9.29; 1432.65]) for their annual earnings, and a positive and significant covariance value of 31.31 (with 95% CI [0.27; 84.57]) between annual earnings and medical care spending. This later result suggests that as immigrant families' annual earnings increase, so do their annual medical care spending and vice versa. Using the estimated variances and covariance, we calculate the correlation coefficient between annual earnings and medical care spending to be $\tilde{\rho} = 0.072$ or $[31.31 / (\sqrt{403.72} * \sqrt{474.22})]$. This result indicates a small yet statistically significant correlation between immigrant families' annual earnings and medical expenditures in the U.S.

4.2.2 ELP effects on earnings and medical care spending propensities

The results of ELP on immigrant families' annual earnings suggest that limited ELP has a consistently negative and increasing effect on families' propensity to earn income. In fact, among the immigrants that reports speaking English very well, a one level decrease in ELP is found to reduce average annual earnings propensity by \$44.83 (with 95% confidence interval [-\$90.32; -\$7.35]). This figure rises to \$50.66 (with 95% CI [-\$102.20; -\$8.73]) among the immigrants that report speaking English well, and increases further to \$56.97 (with 95% CI [-\$114.56; -\$9.95]) among the immigrants that reports not speaking English well. These results seem to indicate an approximate average premium of \$6, for each level of immigrants' ELP in post-ACA-USA.

The results of ELP on immigrant families' annual medical care spending also suggest that limited ELP has a consistently positive effect on families' propensity to spend on medical care. In fact, among the immigrants that reports speaking English very well, a one level decrease in ELP is found to increase average annual propensity to spend on medical care by \$8.09 (with 95% CI [\$0.73; \$16.49]). This figure is however reduced to \$6.09 (with 95% CI [\$0.14; \$13.41]) among the immigrants that report speaking English well, and decreases further to \$4.32 (with 95% CI [-\$0.71 ; \$11.04]), among the immigrants that report not speaking English well.

4.2.3 Control variables effects on immigrant families earnings propensity

The effects of the socio-demographic qualitative control variables on immigrant families' annual earnings show that families with adult female respondents have lower earnings propensity -10.94 (with 95% CI [-21.99; -1.91]) compared to those with adult male respondents. Similarly, compared to families with a white adult respondent, those with black adult respondents have lower earnings propensity -2.19 (with 95% CI [-5.89; -0.06]), while those with Asian adult respondents have higher earnings propensity 5.33 (with 95% CI [0.84; 10.95]). In addition, compared to immigrant families with currently married adults' respondents, those with never married respondents have lower earnings propensity -3.81 (with 95% CI [-8.31; -0.47]). Furthermore, compared to immigrant families with adults respondents having extended health insurance coverage, the families lacking such coverage have lower earnings propensity -4.43 (with 95% CI [-9.19; -0.68]). Similarly, compared to families with adult respondents paying medical bills over time, those who do not pay overtime have higher earnings propensity of 5.35 (with 95% CI [0.83; 11.06]). In addition, families with adult respondent lacking a flexible spending account have a lower earnings propensity, -6.84 (with 95% CI [-13.96; -1.10]), compared to families who use a flexible spending account.

With respect to physical health status, compared to families with adult respondents reporting an excellent health condition, families reporting any other health status have a lower annual earnings propensity. In fact, these figures are -0.22 (with 95% CI [-2.01; 1.34]) for those reporting a very good health status, -2.61 (with 95% CI [-6.09; -0.25]) for those reporting a good health status, -2.78 (with 95% CI [-7.43; -0.21]) for those reporting a fair or poor health status.

The effects of the quantitative control variables show that a one hour increase in weekly labor supply by the adult respondent significantly increases immigrant families earnings propensity by \$0.60 (with 95% CI [\$0.10; \$1.20]). Similarly, a one-year increase in adult respondent's age significantly increases earnings propensity by \$0.16 (with 95% CI [\$0.02; \$0.34]). Moreover, each level increase in adult respondents' education increases earnings by \$1.94 (with 95% CI [\$0.34; \$3.89]). Finally, every dollar spent on health insurance premium by the adult respondent increases earnings propensity by \$0.07 (with 95% CI [\$0.01; \$0.15]).

4.2.4 Control variables effects on the propensity to spend on medical care

The effects of the socio-demographic qualitative control variables on immigrant families' propensity to spend on medical care show that families with adult female respondents have a spending propensity that is 1.27 greater (with 95% CI [0.03; 2.98]) than those with adult male respondents. Moreover, families with black adult respondents and those with Asian adult respondents have lower propensities of - 3.78 (with 95% CI [-7.11; -0.40]), and -1.91 (with 95% CI [-3.92; -0.13]) to spend on medical care when compared to white respondents.

In addition, compared to immigrant families with currently married adults', those previously married and those never married have lower propensities of spending on health care of -5.53 (with 95% CI [-10.02; -0.62]) and -4.66 (with 95% CI [-8.45; -0.57]), respectively. Furthermore, compared to immigrant families with extended health insurance coverage, the

families with who lack coverage have lower medical care spending propensity of -1.82 (with 95% CI [-3.75; -0.15]). Similarly, compared to families with adult respondents paying off medical bills over time, those with adults not doing so have lower medical care spending propensity of -13.90 (with 95% CI [-23.30; -2.40]). In addition, families who report having no flexible spending account have a lower medical care spending propensity of -5.73 (with 95% CI [-9.94; -0.67]), compared to families who have a flexible spending account.

With respect to physical health status, families with adult respondents reporting any other physical health status have higher medical care spending propensity compared to respondents reporting an excellent health condition. In fact, these figures are 1.70 (with 95% CI [0.08; 3.69]) for those reporting a very good health status, 3.96 (with 95% CI [0.41; 7.21]) for those reporting a good health status, and 7.72 (with 95% CI [0.86; 13.83]) for those reporting a fair or poor health status.

The effects of the quantitative control variables show that a one-year increase in an adult respondent's age significantly increases medical care spending propensity by \$0.12 (with 95% CI [\$0.01; \$0.23]). Moreover, each level increase in adult respondents' education increases medical care spending propensity by \$0.26 (with 95% CI [\$0.02; \$0.52]). Furthermore, every dollar spent on health insurance premium by an adult respondent increases medical care-spending propensity by \$0.10 (with 95% CI [\$0.01; \$0.17]). Finally, the cutoff points results for the ordered response variables show a posterior mean value of $\delta_2 = 20.57$ (with 95% CI [3.79; 41.46]) for annual earnings, and $\mu_2 = 17.67$ (with 95% CI [2.24; 28.57]) for annual medical care spending.

5 Discussions of the results

Given the multiple ways in which health insurance can enhance the economic and social well-being of immigrants and their families, and given that immigrants and their children are less likely to have health insurance, addressing issues of immigrants' health care market integration is of the outmost importance, and complementary to their economic integration.

In 2004, prior to the ACA, the United States spent around \$1.9 trillion, or 16 % of its gross domestic product (GDP) on health care; this averages to about \$6,280 for each man, woman, and child (Stanton and Rutherford, 2006). By 2012, health spending reached \$2.8 trillion, or \$8915 per person, and accounted for 17.2% of gross domestic product (Jaffe and Frieden, 2014). After the ACA took effect however, Chua and Sommers (2014) showed that the dependent coverage provision improved protection against medical costs (a 3.7 percentage points reduction in out-of-pocket expenditure) among adults aged 19 to 25 years compared with older adults relatively unaffected by the law. Furthermore, Allison (2017) reported a reduction in the odds of out-of-pocket and total expenditures exceeding zero for the elderly and near elderly (60 to 70) enrolled in Medicare. This improvement has also been felt in the U.S. immigrant population, which recorded disproportionate gains in health insurance coverage under ACA. About 5.9 million more nonelderly immigrant adults and 1.9 million more children of immigrants accessed health coverage in 2015, compared to the figures in 2010.

Our findings show that limited English language proficiency leads to higher propensities of medical care spending in the U.S. immigrant population. If true, then policies that improve immigrants ELP in the USA would have significant implications for immigrants contribution

to national health care spending as well as economic prosperity. In fact, in light of our results, improved immigrants' ELP should contribute to reducing the per capita national medical expenditure of \$10,500 reported by Phelps (2017) for the 325 million people living in the U.S. as of 2016. In addition, improved ELP along with better health care coverage would improve well-being for immigrants and their children. The latter group, by accounting for about one in four (24%) of all children under 18 years old in the U.S., will play an important role in the future workforce. As such, keeping them (and their parents) healthy so they are better able to reach their full potential, and strengthen the U.S. economy for the coming decades will be more of a strategic investment worth consideration.

Furthermore, this study also revealed that limited E proficiency reduced immigrant families' annual earnings propensity in post-ACA-USA. Given the potential adverse health care market effect of limited ELP as discussed above, and the interdependence between the U.S. health care market and labor market (Niankara, 2018b), this result is not so surprising. Since labor supply and earnings depend on health capital (Grossman, 1972), adverse health outcomes due to limited ELP can but reduce labor supply, and earnings (Chiswick and Miller, 2017). Authors are divided on ACA effects on U.S. labor market, some suggest an adverse effect on labor supply (Colman and Dave, 2018; Depew, 2015), others report no substantial change (Heim et al., 2015; Schoen, 2016), while others further report inconclusive effects (Gaudette et al., 2016). Our latter result suggests however that improving ELP for immigrants' families would not only have a direct effect on immigrants' labor supply and earnings potential in post-ACA-USA, but also have an indirect effect through better health care market outcomes.

Although this study is the first to investigate the joint effects of English language proficiency on health care market and the labor market outcomes, the results are consistent with those examining the issues separately. Indeed the statistically positive and significant correlation coefficient between immigrants families' annual earnings and medical care spending, suggests that jointly modelling the two processes adds value to our overall understanding of the relationships between the various dimensions of immigrants integration in the USA.

Furthermore, our finding that limited ELP adversely affects immigrants' health care market integration through increased medical care spending propensity is supported by others. For instance, Gonzalez et al. (2010) showed that U.S. immigrants with limited ELP tend to have poorer understanding of their illness, and lack understanding of the treatment that they receive. Similarly Clark et al. (2004) showed that immigrants with limited ELP are less likely to follow treatment instructions and physician's recommendations or to pay follow-up visits. In addition, Divi et al. (2007) also showed that they have difficulty accurately expressing their symptoms, inhibiting physicians' ability to accurately diagnose. All of these contribute to unnecessary diagnostic testing and hospital admissions (Lopez et al., 2015) and thereby to increased unnecessary medical care spending.

Finally, our finding that limited ELP adversely affects immigrants' labor market integration through reduced earnings propensity is also supported by the past literature. Indeed Chiswick and Miller (2015) shows that immigrants tend to have weaker economic position at arrival because of low ELP. A result initially reported by Miranda and Zhu (2013), and further confirmed by Schuss (2018). This is mostly so, because increased ELP helps immigrants'

access information and social contacts, allowing them to build more cultural knowledge, and thereby adjust more easily to the labor market in the United States.

6 Conclusions

In this paper we have analyzed the effects of self-reported English language proficiency on U.S. immigrant families' annual earnings and medical care spending. Using data from the U.S. National Health Interview Survey (NHIS) from 2015, 2016, 2017 the U.S. we explore the relative importance of linguistic integration on immigrants' health and economic integration in receiving host countries. Given the cross-sectional multi-stage probabilistic sampling design of the NHIS and the qualitative ordinal nature of our three interrelated dimensions of immigrant integration (English Language Proficiency, Annual Earnings, Annual Medical Care Spending), we rely on a mixed bivariate ordered probit modeling with Bayesian Markov Chain Monte Carlo estimation.

Our analysis produces several interesting results with significant implications for immigration and health care policy reform in the U.S. The findings are 1) Among immigrants, increased ELP improves earnings propensity in post-ACA-USA. 2) As Among immigrants, increased ELP reduces medical care spending propensity in post-ACA-USA. 3) There is a significant positive correlation between immigrants' families' annual earnings and medical care spending in post-ACA-USA. We conclude therefore that overall, the evidence from the pooled cross-sectional sample data of the last three waves of the NHIS is not enough to reject any of our three formulated hypotheses. Therefore we conclude that efforts to improve immigrants' ELP in the U.S. would lead to greater integration into U.S. society and labor force leading to greater earnings as it leads to relatively greater spending on health care by the immigrant families, themselves. One implication of this is that public assistance to fund health care of immigrants may eventually fall as immigrants earn more and better integrate into the greater U.S. society.

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Declaration of interest

None

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