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EUI Working Paper **RSCAS** 2019/45

ISSN 1028-3625

Printed in Italy, July 2019
European University Institute
Badia Fiesolana
I – 50014 San Domenico di Fiesole (FI)
Italy
www.eui.eu/RSCAS/Publications/
www.eui.eu
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Abstract

This paper uses U.S. time-diary surveys to study the allocation of time devoted to informal learning and education by immigrants and natives. We develop a simple theoretical framework, which highlights the different constraints and opportunity costs faced by immigrants as compared with natives. In line with our theoretical model, the estimates show that immigrants are more likely to engage in informal education and, conditional on participation, they allocate more time to these activities. The investment in informal learning and education activities is likely to boost immigrants' human and social capital and contribute to socio-economic integration.

Keywords

Immigrants, time-use, education, human capital, U.S.

I. Introduction*

As the number of immigrants has increased in all developed countries, debates about the processes of socio-economic integration of foreign-born persons have become much more important and contested in policy circles and among the public. Comparisons of immigrants and natives can provide an important assessment of the degree of integration of migrants. There is an abundant economic research literature that has investigated immigrants' performance and behaviour with respect to several outcome variables such as wages, labor market participation, crime rates, use of welfare support schemes, etc. Less attention has been devoted in the literature to the processes that lead to the observed outcomes and the resources allocated to them.

In this paper, we study the time allocated to informal education by immigrants (and natives) in the US. For immigrants the investment in informal education might represent a fundamental channel of socio-economic integration. In addition, these human capital enhancing activities generate individual-level as well as community-wide returns[1]. In their decision to invest in human capital, immigrants face different constraints compared to natives. As barriers to formal educational channels might be particularly high[2], informal education might represent the only real channel for investing in human capital in the host country.

Also, the opportunity cost of investing in these activities might diverge as the time allocated to non-market-activities is closely related to the shadow price of time and to the productivity of consumption time (Becker 1965). Informal education can also be considered an investment in social capital as, compared to natives, the density of immigrants' social networks is limited (Coleman 1988).

In our study we define informal education as all the activities that have a formative content such as taking a class for personal interest and extra-curricular club activities. These activities are closely related to lifelong learning and are increasingly important, considering rapid technological changes and automation of production processes.

To our knowledge, this is the first study that analyzes immigrants' decisions to invest time in informal education and that investigates the process of assimilation in terms of informal education over time. In the first part of the paper, we present a dynamic theoretical framework that allows us to analyze the individual decision of investing in informal education and the role played by the initial level of human capital. In the second part, we test the main predictions of the model using the American Time-use dataset (ATUS) for the period 2003–15. One of the important novelties of our approach is the use of time allocation data. As argued by Hamermesh and Pfann (2005, page 2) "no other sorts of data allows us to analyze the determinants of how people allocate time outside the labor market".

We show that foreign-born persons are more likely to engage in informal education and, conditional on engaging, they spend more time on these activities than natives. Although we provide evidence of assimilation with natives, we find that this process is rather slow, and some differences carry on to second-generation immigrants.

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* Rezart Hoxhaj thanks Stiftung Mercator for financial support under project number PN 14-297. We wish to thank participants in the following seminars and conferences: University of Lille, University of Modena-Reggio Emilia, International Conference on Economics of Global Interactions (Bari, Italy), European University Institute (Florence, Italy).

1 Educational and training activities outside formal channels are important ingredients of human capital enhancement for broad groups of workers. These investments of time and resources in general improve employment opportunities and might lead to higher wages. Lifelong learning and skill updating are fundamental during the working life of an individual (OECD 2014, Skills beyond school), particularly in occupations characterized by fast technological change. According to Fahr (2005), formal education accounts only for a limited part of the required knowledge in the labor market.

2 High barriers to formal education for immigrants might be, for instance, related to costly and lengthy recognition procedures or to limited proficiency in the host-country language.

Our paper adds to a limited number of recent contributions on the time-use of immigrants (see Ribar 2012 for a survey). Significant differences between immigrants and natives in time allocated to 'assimilation activities' (purchasing, education, work) are highlighted by the important contribution of Hamermesh and Trejo (2013). This study, using ATUS data, shows that immigrants are less likely to undertake assimilation activities, but those who do engage in such activities spend relatively more time than natives. The authors rationalize these findings on the basis of a theoretical framework in which immigrants experience both higher fixed costs and higher returns from time devoted to assimilation activities.

Recent studies from different fields have used time-use data. Vargas (2016) focuses on time allocation of Mexican immigrants in the US over ten mutually exclusive activities using 2003–12 ATUS data. Their analysis provides evidence of differences in time devoted to work/commuting/leisure by gender and marital status.

An interesting study carried out by Zaiceva and Zimmermann (2014) shows, using data on a sample of immigrants and native women in the United Kingdom, that non-white-women (mainly those originating from Pakistan and Bangladesh) spend significantly more time on food management and particularly religious activities than white women. The study employs a double-hurdle model which jointly analyses the decision to engage in a particular activity (namely childcare, food management and religious observance) and the minutes of time devoted to it.

More recently, Caparros Ruiz (2017) has investigated immigrant workers' time-use in Spain, a country that has experienced a sudden and considerable increase in its immigrant population. In this study, important differences between immigrants and natives in the allocation of time to a broad set of categories emerge. Male immigrants from outside the EU are found to invest more time in studying and other activities related to training.

The only study on the determinants of time allocated to informal education activities is, to our knowledge, the analysis conducted by Fahr (2005). Using time-use data for Germany, this study finds evidence of a strong relationship between formal and informal education, but Fahr's analysis has no specific focus on immigrants.

The paper is organized as follows. Section II describes the theoretical framework from which we derive some testable hypotheses. Section III describes the data used and the empirical strategy we employ in our analysis. Section IV presents the results. Section V summarizes the results and presents the main conclusions of the paper.

II. A Simple Theoretical Model

Let us consider an agent living during a time interval $[0, T]$. At every date *t*, the agent is endowed with $\bar{\theta}$ units of time that can be allocated to three different activities: consumption (c_t), work (θ_t) and informal education (e_t). We can express the time constraint as follows:

$$\forall t: \theta_t + c_t + e_t \leq \bar{\theta}$$

Time allocated to work generates an income $(h_t)\theta_t$, where $w(h_t)$ is the wage of the agent, which is a concave increasing function of her current human capital level, h_t. Let us assume that consumption activities are carried out combining time and commodities (that is, goods and services purchased in the market). In other words, c_t units of time devoted to consumption need c_t units of commodities, bought in the market drawing from individual income at price *p* which we normalize to unity. Then, the agent faces the following budget constraint:

$$c_t \leq w(h_t)\theta_t$$

Informal education contributes to the accumulation of human capital. More precisely, the accumulation of human capital follows the equation:

$$\dot{h}_t = a\, max(e_t - \varepsilon, 0)$$

where $\dot{h}_t$ is the time derivative of h_t, a is the efficiency of informal education in generating new human capital and $\varepsilon < \bar{\theta}$ is a sunk time cost: only time devoted to informal education beyond ε contributes to human capital accumulation.
The agent maximizes the following intertemporal utility function:

$$V = \int_0^T e^{-\rho t}\, u(c_t) dt$$

where $u(c_t)$ is a standard concave increasing instantaneous utility function.

Given our assumption that informal education is not a direct source of utility, the existence of the sunk time cost, ε, implies that either the agent is not involved in informal education ($e_t = 0$) or devotes at least ε units of time to informal education[3].

The full solution of the model is developed in *Appendix 1*. Here, we informally present the main results. Two forces determine the optimal choice of time devoted to informal education: decreasing returns to human capital and the length of remaining life. Decreasing returns to human capital imply that, the higher the current level of human capital, the lower the future return to the new human capital generated by informal education. The shorter the remaining life, the lower the future return of capital accumulated with informal education. This effect will be particularly strong if informal education is largely undertaken, as we assume here, for productive purposes rather as a pure leisure good (that is, for consumption purposes).

If the initial level of human capital, h_0, is high enough, the agent decides not to engage in informal education ($e_t = 0$, all t) because of the decreasing marginal returns to human capital: the marginal increase in consumption generated by additional informal education is too low. For lower values of h_0, the agent starts devoting some time to informal education above the sunk time cost: $e_T > \varepsilon$. Both the decreasing returns to human capital and the shortening of the remaining life imply that the time devoted to informal education decreases with ***age*** and agents who are old enough may not be involved in informal education.

Decreasing returns to human capital imply that, at every age, an agent who starts from a higher ***initial level of human capital*** (h_0 higher) must devote less time to informal education than an agent whose initial endowment in human capital is lower. Most immigrants are less endowed in human capital than natives and, moreover, human capital accumulated in the home country is often imperfectly transferable to the home country. Then, we expect immigrants to be more frequently engaged in informal education and, when they are, to devote more time to these activities.

A further prediction relates to the ***time constraint***: agents who have more time available everyday ($\bar{\theta}$ higher) choose to devote more time to informal education. Intuitively, agents who have more time resources devote some of these extra time resources to informal education. In this respect, the status of immigrant might have an ambiguous effect. One the one hand immigrants—by being less rooted in the host society—might experience lower time-absorbing social obligations but, on the other hand, their

[3] Informal education often includes activities that can be considered as leisure goods, hence producing direct utility to consumers. Here we do not consider the possibility of direct utility from informal education for simplicity and without loss of generality. The removal of this simplifying assumption would not change the main predictions of the model but would increase the analytical complexity.

time-use might be affected by more binding credit constraints or can be absorbed more by time-consuming non-productive-activities such as commuting (see Hamermesh and Trejo 2013).

The model also predicts that agents who have a higher efficiency in generating human capital from informal education (in the model above, parameter a is higher) devote more time to informal education. The effects of informal education activities on human (and social) capital might be particularly important for immigrants who face higher barriers to alternative mechanisms of human capital accumulation such as formal education. Finally, agents who are more impatient (ρ higher) choose to devote less time to informal education. Intuitively, more impatient agents value less the future gain from the increase in human capital generated by informal education. Generally speaking, immigrants tend to discount the future less than natives and are more likely to accept and trade-off temporary hardships against future gains. In the next step of our analysis we test empirically these theoretical predictions.

III. Data and Methodology

A. Description of the Data

We use the American Time-use Survey (ATUS) for the years 2003–15 in our analysis[4]. Individuals surveyed in ATUS are selected randomly from households that participate in the Current Population Survey (CPS). The sample is representative of the population residing in the United States. Data is collected through one-day time diaries[5], where participants list the time (in minutes) allocated to activities performed in the 24 hours prior to the survey. These activities are defined over a set of standardized categories (approximately 400). Finally, for each respondent, information on time-use can be matched with a wide array of demographic characteristics and labor market situation collected by the CPS. The dataset we use includes approximately 170 thousand observations, where immigrants account for 14,5 percent of the total number.

Time-diary method has several advantages compared to other data collection methods (see Ribar 2012; and Juster, Ono, and Stafford 2003 for an overview). The most important one is accuracy that stems from the short recall period and the episodic format (must add up to 24 hours) which allows for consistency checks by the user. Barrett and Hamermesh (2019) argue that this type of data also reduces errors related to the different importance given to activities by survey respondents (see Bound, Brown, and Mathiowetz 2001).

Conversely, two main disadvantages of the data are worth mentioning. The first limitation of the time-use data is highlighted by Juster, Ono, and Stafford (2003) who show that reporting on occasionally performed activities tend to be less reliable. However, in our study, this limitation is not an issue as most activities that belong to the informal education category are not occasional and are likely to have a well-defined time schedules. The second limitation is related to the high variability of time-diary data due to the one-day observation[6]. If interviewed on different days during the year, responses are likely to vary across days. One possible effect of the high variability is the reduction of the statistical power of the model, especially when estimations use a low number of observations (usually the 2 Tier in our estimations). We show below that this drawback is unlikely to undermine our results.

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[4] The ATUS data set is publicly available upon registration. We used the American Time-use Survey Extract Builder to extract the data (Hofferth, Flood, and Sobex 2017) https://www.atusdata.org/atus/

[5] ATUS diary days are assigned randomly and distributed across the days of the week, with 10 percent allocated to each day of the week and 25 percent allocated to Saturday and Sunday. This distribution is based on research showing that in weekends the allocation of time is different as compared to the rest of the working days (Horrigan and Hertz 2004).

[6] The most notable differences are between weekdays and holidays for which we control using a dummy that distinguishes between weekdays and holidays.

Table 1 reports the descriptive statistics of the dependent variables (informal and formal education). All statistics are weighted to reflect the behavior of a representative individual in the US on a representative day. The first row in *Table 1* presents the time spent in informal education by both immigrants (column 1) and natives (column 2). The sample average time spent in informal education by immigrants (1.74 minutes) is almost double of the time spent by natives (0.98 minutes). These activities are performed more frequently by immigrants (1.2 percent) than by natives (0.9 percent). Conditional on participation, immigrants are also shown to spend more time in informal education than natives (141 minutes vs. 108 minutes). These aggregate statistics are in line with the pattern predicted by our theoretical model. With regard to time spent in formal education, no relevant differences exist between immigrants and natives. *Table 2A* in *Appendix 2* shows that immigrants and natives are comparable in terms of gender, employment status and attainment of advanced degrees (degree and postgraduate). Immigrants are of younger age, are more likely to be married and to have children than natives. They are also less likely to have obtained a secondary school license than natives (50 percent and 64 percent, respectively). Summary statistics also show that the presence of illiterate individuals in the survey is very low, among both immigrants and natives (1,06 percent). This feature reduces the likelihood of errors in reporting of activities from individuals[7].

B. Estimation Strategy

To test our hypothesis, we employ a double-hurdle (two tier) method proposed by Cragg (1971) and used to analyze differences in the allocation of time between natives and immigrants over broad classes of activities by Hamermesh and Trejo (2013). The double-hurdle method incorporates a probit model in the first tier that gives the probability that the observation has a positive value and a truncated regression in the second tier. As an alternative to a Tobit, this method allows for the possibility that different processes determine the two tiers, and hence the model could be estimated over two vectors of parameters. In terms of our analysis, the probit model (1st tier) will test if immigrants and natives have a dissimilar probability to participate in informal education, while the truncated model (2nd tier), conditional on engaging in informal education, will test if immigrants participate more intensively than natives in such activities. The specification of the baseline model is presented below:
1st tier: Probability of participation

$$Y_{ist}(0,1) = \alpha_0 + \beta_1 ForeignBorn_{ist} + \boldsymbol{\beta}_2 \boldsymbol{X'}_{ist} + \boldsymbol{\beta}_3 \boldsymbol{Z'}_{ist} + \boldsymbol{\varphi'}_s + \boldsymbol{\gamma'}_t + \varepsilon_{ist}$$

2nd tier: Intensity of participation

$$InformalEdu_{ist} = \gamma_0 + \delta_1 ForeignBorn_{ist} + \boldsymbol{\delta}_2 \boldsymbol{X'}_{ist} + \boldsymbol{\delta}_3 \boldsymbol{Z'}_{ist} + \boldsymbol{\varphi'}_s + \boldsymbol{\gamma'}_t + \omega_{ist}$$

1. Dependent Variables

We define *informal education* as all extracurricular activities that have a human capital component and classes carried out outside the formal educational system. *Table 2B* in *Appendix 2* reports the list of activities included in the definition of informal education. Given the nature of the data generation process, we could not further disaggregate the informal education variable and distinguish between activities such as language courses or academic classes from other activities which besides having human-capital enhancing effects, can be considered as quasi-leisure activities[8]. This definition is similar

[7] Note that in order to minimize coding and classification errors, individuals describe the activities they perform using their own words. These activities are, therefore, classified into a set of standardized activities by ATUS staff.

[8] According to ATUS staff, after a time-diary is processed and codified into standardized categories the original recording is destroyed and hence not accessible to researchers. Although further disaggregation of this variable would have potentially revealed some heterogeneous effects depending on the specific activity, our main idea is to consider all the activities—including those that have a strong leisure component—that generate at least potentially positive effects on the accumulation

to the definition used by Fahr (2005). More specifically, the dependent variable in the 1st tier equation (Y_{ist}) is dichotomous and equals 1 if the respondent *i* declares to have spent time (minutes > 0) in informal education during the day the time-diary was recorded, and 0 otherwise. The dependent variable in the 2nd tier equation ($InformalEdu_{ist}$) is continuous and measures the time spent (in minutes) in informal education by the respondent *i* during the day the time-diary was recorded. In some estimations, we use as dependent variables the probability to engage in formal education and the time spent in those activities. Formal education includes non-work-education only (taking classes and performing educational activities including research and homework for a degree).

2. Explanatory and Control Variables

Our main explanatory variable is $ForeignBorn_{ist}$. It is equal to 1 if the individual *i*, who resides in state *s* in year *t*, was born abroad and 0 otherwise. Based on our theoretical framework, we expect that foreign born persons might be more likely to allocate time to informal education for the following reasons: i) partial transferability of human capital might imply that marginal returns to informal education are higher even controlling for educational attainment; ii) immigrants might have a more restricted set of options for human capital enhancing activities; iii) immigrants are generally more patient and discount the future relatively less than natives.

The vector $\boldsymbol{X'}_{ist}$, in both equations, contains individual level characteristics that might condition the propensity to participate in informal education and the intensity to perform informal education activities such as: the age of respondent and its quadratic form (*Age)* and its quadratic form (*Age squared*); gender (*Female*); marital status (*Married*); the respondent has a child in these age groups (*No children, children 0-2 years, children 3-5 years, children 6-12 years, children 13-17 years*); education attainment (*Illiterate, Elementary, Middle, Secondary, Degree, Postgraduate*). We include in our model a set of dummies for the work status of the individual (*Employed, Unemployed, Not in labor force*) and seven dummies for the size of the area where the individual resides. With respect to age (and its square) we expect, based on the model above, that the return from informal education will be higher for younger individuals as they can reap higher benefits in their longer working life. Other individual level characteristics—such as gender, marital status, number of children and employment status—are included to control for time-constraints that might affect the willingness/ability to allocate time to informal education. For instance, we expect that time-constraints will be less binding for unemployed or individuals not in the labor force and, on average, female individuals. Time-constraints will be more binding for individuals with children.

Educational attainment is our proxy for the initial level of human capital included in the theoretical framework. On the one hand, we expected that higher levels of formal education will be associated with lower incentives to invest in informal education as a consequence of our assumption of decreasing returns related to these human capital enhancing activities. On the other hand, it is important to acknowledge that the leisure value of informal education is likely to be positively related with educational level. Besides, formal and informal education might have a certain degree of complementarity. Both these aspects might be important and might offset the effects explicitly formalized in our theoretical framework.

Moreover, in the baseline model the vector $\boldsymbol{Z'}_{ist}$ contains a dummy indicating whether the diary day is a holiday[9] (*Holiday*) and the vectors $\boldsymbol{\varphi'}_s$ and $\boldsymbol{\gamma'}_t$ refer to state fixed-effects and year fixed effects,

of human as well as social capital. In this respect, participation in a chess club might be considered as a human capital enhancing activity in a way similar to participation in an English language course. Both activities lead to accumulation of skills and improve cognitive abilities that might be useful in the labor market. In addition, both activities lead to social interactions that might have positive effects by increasing returns to other production factors or simply by increasing the chances of employability.

9 Holidays include Sunday, New Year's Day, Easter, Memorial Day, 4th of July, and Christmas.

respectively. For the exact definition of the variables included in our empirical specification we refer the reader to *Table 2C* in the *Appendix 2.*

IV. Empirical Results

A. Baseline Results

Table 2 presents the results of the baseline model. Model 1 (1st tier), estimated over the entire sample, shows that the probability to participate in informal education activities is 18 percent higher for the foreign-born than it is for natives. Conditional on participation (2nd tier), the foreign-born spend, on average, 62 minutes (or 57 percent)[10] more on such activities than US-born people do in the diary day. In this model, we control for a wide range of individual level characteristics, which explain a good part of the heterogeneity in the time spent in informal education across individuals. Consistent with our theoretical prediction, we find that younger individuals and females are more likely to participate in informal education activities. However, the intensity of time spent in such activities is higher for younger individuals, and it is lower for females than for men. As expected, individuals with young children are less likely to engage in informal education activities than those who have no children, and when they engage, the time spent in these activities is significantly lower. Informal education activities are performed more frequently but less intensively during holidays. The labor market status of individuals determines the time spent in informal education activities. Unemployed and inactive individuals are more likely to engage in informal education activities than employed individuals, and the time spent in these activities is evidently higher. Unemployed individuals might engage more intensively in informal education activities to acquire skills and competences that grant a (future) labor-market return. Besides, these individuals are likely to be less time constrained than employed individuals are, as highlighted in our model. Finally, the educational attainment is positively associated with the likelihood to engage in informal education activities. According to Fahr (2005), highly educated people have a higher opportunity cost of their non-market-time and a preference for educational leisure. Another possible explanation is the higher complementarity—both in production and consumption – between formal and informal education. In Models 2 and 3, we exclude unemployed and inactive individuals from the sample—and focus only on employed individuals as these two groups substantially differ in terms of time constraints as well as in terms of the opportunity cost of allocating time to non-market-activities. In Model 3 we also include dummies controlling for household income levels[11]. We find that the probability to participate in informal education for employed foreign-born is 15 percent higher than employed native people and the time spent is also remarkably higher (around 90 percent).

Our theoretical model and the results of the analysis in Table 2 suggest that one reason why immigrants spend more time in informal education is the higher returns they obtain from these activities. Consistent with the theoretical prediction, the economic incentive to engage in human capital enhancing activities is higher for individuals that could reap the benefits for longer time. For instance, those who are close to retirement could have a lower incentive to invest in informal education than individuals at an early stage of their working life.

In Table 3, we test the validity of this argument by including in the baseline model a dummy for foreign-born individuals who are 45 years of age or younger and a dummy for foreign-born individuals who are older than 45 years of age[12]. In Model 1, which includes the results of estimations having informal education as a dependent variable, foreign-born individuals who are 45 years of age or younger

[10] Assessed on the average time spent in informal education by natives.

[11] Income dummies are used to control for the opportunity cost of engaging in non-market-activities.

[12] Only individuals with more than 17 years of age are considered in the estimations. The results hold if the threshold age is 40 years and when only individuals within 17 – 65 years of age are considered. Results are available upon request.

are twice more likely to engage in informal education activities (compared to natives) than foreign-born individuals who are older than 45 years of age. The results show the same tendency when the conditional amount of time spent in such activities is considered.

As argued above, informal education activities could represent a fundamental source of knowledge and country-specific human (and social) capital for immigrants. For example, attending language club activities or taking art and craft courses may boost host country-specific skills/knowledge and language proficiency. It is reasonable to expect that the longer the immigrants reside in the host country, the higher is the level of country-specific human capital accumulated and the lower will be the difference with the human capital of natives. This argument is in line with the assimilation theory suggesting convergence in the use of time between immigrants and natives. To test the validity of this argument, in Table 4 we insert in the baseline model a set of dummy variables categorizing the time since migration of individuals and a dummy for second-generation Americans[13].

Model 1 shows the results for informal education as the dependent variable. In line with our predictions, the propensity to engage in informal education is higher for recent immigrants and decreases steadily in size with the time spent in the US. Immigrants residing in the US for less than 6 years are almost 8 times more likely to engage in informal education than immigrants that were in US for more than 20 years. However, the results also show that the amount of time spent in informal education does not follow a clear decreasing pattern when time since immigration increases.

Second-generation Americans look like natives in terms of time spent in informal education. Their propensity to engage in informal education is higher than that of natives but not too different from that of immigrants that were in US for more than 20 years (9.5 percent and 6.2 percent, respectively). Overall, the results suggest that a slow process of assimilation with natives is ongoing and that this process is not fully completed for the second-generation immigrants.

With regard to time spent in formal education, results in Model 2 resemble what is found for informal education. The propensity (and intensity) to invest in human capital enhancing activities is significantly higher for recent immigrants but then converges (slowly) to that of US-born persons over time. Interestingly, we find that significant—although small—differences carry on to the children of immigrants (second-generation).

A. Formal and Informal Education: The Complementarity Issue

So far, in our analysis, we have excluded the possibility that the time spent in formal education and informal education activities might complement each other. In many cases, classes for a degree could be complemented with additional extracurricular classes or club activities aimed at enhancing the knowledge of a topic or gaining new skills. However, individuals might combine investment in formal and informal education differently. For example, individuals that have already completed their formal educational track may decide to further invest in informal education as a way to avoid skills and human capital depreciation or to update their skills and competences. Evidently, investments in informal education complement previous investments in formal education and occur when individuals have already completed the formal educational track. This latter typology of complementarity has a sequential rather than a contemporary nature[14].

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[13] Both variables are used by Hamermesh and Trejo (2013) to measure the process of assimilation of immigrants in terms of time-used in purchasing, education and work activities. Their definition of education includes both formal and informal education.

[14] We exclude here the possibility that informal education could be performed before enrolling in formal education (for example, high school or university) and could determine further formal education. In any case, this circumstance and sequential complementarity in general does not invalidate the analysis as long as formal and informal education are not performed simultaneously. We control for sequential complementarity by using educational attainment dummies as in Fahr (2005).

When individuals' choices over these two activities are simultaneous (that is, taken in the same period under analysis), the estimates presented above are likely to be biased if formal education is not considered explicitly in the analysis[15]. One way to deal with this issue is to restrict the sample to only those individuals that are not enrolled in formal education, for which the risk of simultaneity is quite low or even absent. The ATUS data has detailed information on whether the respondent was enrolled in school, high school or university in the week preceding the survey. We use this information to identify all individuals that declared to be enrolled in the formal educational system and exclude them from the estimations[16].

In Table 5 we investigate the presence of simultaneity and its effect on the baseline results. In Model 1, where we use the entire sample, we insert a dummy for individuals enrolled in formal education (*In education*) and its interaction with foreign-born (*Foreign-born*In education*). The results of Model 1 are informative in several ways; (i) the positive and significant coefficient of *In education* suggests the presence of simultaneity (that is, enrolled individuals are more likely to engage in informal education); (ii) the positive and significant coefficient of the interaction indicates that simultaneity could be higher for enrolled immigrants; (iii) the positive and highly significant coefficient of the dummy *Foreign-born* indicates that, even after controlling for formal education, immigrants are still more likely to engage in informal education, and conditional on participation, they spend more time in these activities (coefficient of *Foreign-born* in tier 2)[17].

To address the simultaneity issue, in Model 2 and Model 3 we include in the sample only individuals that are not enrolled in the formal educational system. The results of these estimations certify the results obtained on the whole sample of individuals and presented above in Table 1 and Table 2.

A further robustness check on the issue of potential simultaneity is reported in Table 6 where we estimate the baseline model separately for individuals that spend a positive amount of time in formal education (Model 1) and those who spend no time in formal education in the diary day (Model 2). In the former specification (that is, when simultaneity is present), the probability to engage in informal education is not significantly different for foreign born compared to natives. On the contrary, in Model 2—where simultaneity is less likely—results confirm what was previously found in the baseline estimations presented above. Overall, the tests presented in this section confirm that our baseline results are not significantly affected by simultaneity.

V. Discussion and Concluding Remarks

The accumulation of human capital in a society is fundamental for boosting growth, and more generally, the well-being of citizens. When this investment is carried out by immigrants there is an additional gain for the community at large as human capital speeds up the process of socio-economic integration.

In this paper we have focused our attention on informal education, a crucial channel (often the only available one) of human capital enhancement for immigrants. We firstly provide a theoretical framework that allows us to generate hypotheses about the factors that drive individuals' incentives to invest in informal education, and to discuss how immigrants may diverge from natives with respect to some of these drivers. Our empirical findings, in line with our theoretical predictions, show that foreign-born individuals invest more than natives in informal education. The probability of engaging in training and extra-curricular formative activities is higher for foreign-born people than for natives, and the time

[15] If time devoted to formal and informal education are simultaneously decided, then formal education is a crucial determinant of informal education. Hence, it must be controlled for explicitly in the estimations in order to avoid serious omitted variables bias. The fact that formal education is endogenous prevents its use in the econometric model.

[16] Individuals in formal education is only 10 percent of the sample. Note that for those who declare that they are not enrolled, we know their highest educational degree. Hence, we control for their level of educational attainment in the estimations.

[17] As stated in footnote (15), due to endogeneity, these relationships could not be interpreted as causal.

devoted to these activities, conditional on engaging in it, is longer. We show that the main drivers are economic incentives mostly in the early phase of working life, as differences tends to disappear over time, and in particular, when the residual working time is shortened.

We also show that differences between the foreign-born and natives are generally larger in informal education than in formal education. As we are focusing on adults that have already made their decision over formal education when young, these findings show that informal education is fundamental in the process of investing in host-country specific human (and social) capital.

Interestingly, the differences between natives and immigrants persist across generations. We find that second generation immigrants tend to allocate more time to educational activities (also in terms of formal education).

Given the potential importance of informal education for immigrants' integration in the host economy and society, it would be interesting to explore additional dimensions that might facilitate or inhibit time allocated to these activities. Immigrants from different origin countries or living in different areas (such as more or less ethnically segregated ones) might have different propensities to invest in informal education. Analysis on other destination countries might also deliver interesting information that relates to the context in which migration takes place and the policies that govern the phenomena. More data on time-use in different countries are becoming available and more immigrants are being included in these data collection efforts. These interesting questions are left for future research.

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Table 1 Participation and time spent in formal and informal education by immigrants and natives

	Immigrants			Natives		
VARIABLES	Mean	Participation rate %	Conditional mean	Mean	Participation rate %	Conditional mean
Informal education (minutes/day)	1.74 (0.19)	1.2	141 (11.8)	0.98 (0.04)	0.9	108 (3.13)
Formal education (minutes/day)	8.3 (0.83)	3.1	263 (7.4)	8.5 (0.15)	3.2	261 (2.88)
Observations		24865			145.98	

Notes: Statistics are weighted using the variable wt06 (ATUS methodology for 2006). Standard error in parenthesis.

Table 2 Time spent in informal education: immigrants versus natives (baseline estimations)

	Model (1) Full sample		Model (2) Only employed		Model (3) Only employed	
VARIABLES	Tier1	Tier2	Tier1	Tier2	Tier1	Tier2
Foreign Born	0.179***	62.04***	0.151***	96.77***	0.157***	86.56**
	(0.022)	(23.66)	(0.0372)	(37.16)	(0.0419)	(35.98)
Age	-0.024***	9.376**	-0.036***	8.959	-0.036***	6.475
	(0.00356)	(3.659)	(0.005)	(5.931)	(0.005)	(7.243)
Age^2	0.0002***	-0.121***	0.0003***	-0.131*	0.000***	-0.108
	(0.000)	(0.041)	(0.000)	(0.071)	(0.000)	(0.0862)
Female	0.159***	-36.10*	0.133***	-34.96	0.136***	-37.15
	(0.019)	(21.93)	(0.0247)	(30.09)	(0.024)	(30.05)
Married	0.0290	7.330	0.004	-6.327	0.0125	9.986
	(0.023)	(27.97)	(0.026)	(44.64)	(0.033)	(51.34)
Children 0-2	-0.270***	-102.9**	-0.176***	-107.0	-0.186***	-153.1**
	(0.039)	(50.21)	(0.059)	(73.33)	(0.062)	(70.69)
Children 3-5	-0.121***	-127.5***	-0.092*	-158.1***	-0.105*	-162.2***
	(0.037)	(39.64)	(0.049)	(59.12)	(0.056)	(62.37)
Children 6-12	-0.095***	-12.58	-0.064	-17.91	-0.069	-35.43
	(0.029)	(23.19)	(0.040)	(35.39)	(0.043)	(38.20)
Children 13-17	0.005	-16.56	0.038	-9.298	0.033	10.27
	(0.032)	(30.55)	(0.040)	(46.36)	(0.041)	(55.67)
Illiterate	0.405*	-203.8*	0.032	274.8*	-3.061***	0
	(0.236)	(106.0)	(0.456)	(166.3)	(0.234)	(0)
Middle school	0.410**	80.67	0.211	222.3	0.174	325.4*
	(0.205)	(127.7)	(0.241)	(149.0)	(0.231)	(195.8)
Secondary	0.399**	111.3	0.035	267.6*	-0.002	337.9*
	(0.203)	(118.0)	(0.255)	(144.5)	(0.250)	(187.8)
Degree	0.577***	139.7	0.225	319.1**	0.187	396.8**
	(0.204)	(125.3)	(0.252)	(145.4)	(0.250)	(179.6)
Postgraduate	0.694***	118.7	0.340	327.9**	0.283	415.3**
	(0.200)	(120.5)	(0.252)	(145.4)	(0.256)	(181.7)
Holiday	0.139***	-105.5***	0.173***	-57.56	0.168***	-47.25
	(0.048)	(26.59)	(0.045)	(35.21)	(0.047)	(36.30)
Unemployed	0.185***	68.69**				
	(0.033)	(27.12)				
Not in labor force	0.205***	79.98***				
	(0.025)	(22.94)				
Household income dummies	*NO*		*NO*		*YES*	
Constant	-2.397***	-308.5*	-1.830***	-495.1*	-1.875***	-593.5*
	(0.218)	(162.3)	(0.253)	(261.1)	(0.275)	(346.6)
Sigma		191.1***		191.0***		191.9***
		(18.43)		(23.01)		(21.86)
Observations	169,724	1665	105,925	865	98,216	768

Dependent variables: 1st Tier is informal education (0,1); 2nd Tier is time spent in informal education. Reference categories are: No children; Primary; Employed. Area size dummies, state and year fixed effects are used in all models. Errors are clustered at the state level. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3 Residual working life and time-use in informal education

	Model (1)	
VARIABLES	Tier1	Tier2
Foreign born <= 45age	0.261***	62.98**
	(0.0315)	(29.36)
Foreign born > 45age	0.112***	21.87
	(0.024)	(37.20)
Constant	-2.749***	-139.4
	(0.211)	(147.7)
Sigma		181.5***
		(16.06)
Observations	162,236	1449

Dependent variables: 1st Tier is informal education (0,1); 2nd Tier is time spent in informal education. Individuals over 17 years old are considered. This table includes all control variables as in Table 2 and results are available in the Online Appendix. Errors are clustered at the state level. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 4 Time since migration and time-use in informal and formal education

	Model (1) Informal education		Model (2) Formal education	
VARIABLES	Tier1	Tier2	Tier1	Tier2
Second generation	0.095**	12.43	0.081**	37.61***
	(0.047)	(40.53)	(0.038)	(12.98)
Year since immigration:<6	0.502***	101.1**	0.343***	52.79***
	(0.060)	(44.80)	(0.041)	(19.83)
Year since immigration: 6-10	0.275***	-9.040	0.172***	56.10**
	(0.052)	(68.47)	(0.062)	(24.59)
Year since immigration: 11-20	0.279***	71.00**	0.072**	24.19
	(0.030)	(31.97)	(0.036)	(23.17)
Year since immigration:>20	0.062*	44.20	0.015	40.43**
	(0.036)	(31.77)	(0.029)	(20.39)
Constant	-2.668***	-123.5	-0.221	6.754
	(0.211)	(161.9)	(0.201)	(170.2)
Sigma		184.0***		256.0***
		(16.12)		(6.251)
Observations	162,236	1449	162,236	4673

Dependent variables: 1st Tier is informal education (0,1); 2nd Tier is time spent in informal education. Individuals over 17 years old are considered. This table includes all control variables as in Table 2 and results are available in the Online Appendix. Errors are clustered at the state level. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5 Informal and formal education of immigrants: substitutes or complements?

	Model (1)		Model (2)		Model (3)	
	Full sample		Not in education		Not in education	
VARIABLES	Tier1	Tier2	Tier1	Tier2	Tier1	Tier2
Foreign born	0.160***	50.25**	0.172***	46.67**		
	(0.026)	(23.89)	(0.025)	(21.93)		
In education	0.306***	-31.68				
	(0.037)	(47.05)				
Foreign born*In education	0.111**	43.94				
	(0.054)	(44.89)				
Foreign born <= 45age					0.255***	55.74**
					(0.0382)	(28.16)
Foreign born > 45age					0.101***	24.77
					(0.025)	(35.75)
Constant	-2.79***	-260.4*	-3.00***	4.935	-3.25***	7.032
	(0.243)	(151.9)	(0.240)	(129.6)	(0.242)	(139.4)
Sigma		190.8***		172.9***		170.6***
		(18.32)		(16.39)		(16.42)
Observations	169,724	1665	153,093	1279	151,912	1254

Dependent variables: 1st Tier is informal education (0,1); 2nd Tier is time spent in informal education. Individuals over 17 years old are considered. This table includes all control variables as in Table 2 and results are available in the Online Appendix. Errors are clustered at the state level. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 6 Informal and formal education for immigrants: substitute or complements?

	Model (1)		Model (2)	
	Time spent in formal edu>0		Time spent in formal edu=0	
VARIABLES	Tier1	Tier2	Tier1	Tier2
Foreign Born	0.104	17.27	0.193***	56.70**
	(0.076)	(42.70)	(0.022)	(22.03)
Constant	0.176	312.1	-2.745***	-128.2
	(0.796)	(278.4)	(0.220)	(149.4)
Sigma		106.5***		186.3***
		(20.04)		(16.48)
Observations	8,149	195	161,586	1470

Dependent variables: 1st Tier is informal education (0,1); 2nd Tier is time spent in informal education. Individuals over 17 years old are considered. This table includes all control variables as in Table 2 and results are available in the Online Appendix. State fixed effects are not included in model 1 because the model does not converge. Errors are clustered at the state level. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix 1

Determination of the trajectories of informal education and human capital accumulation

In this note we describe in detail the analysis of the optimal trajectories of investment in informal education by the agent and the subsequent accumulation of human capital. Let us start from the fact that, once time devoted to informal education, e_t, is known, the values of time allocated respectively to consumption, c_t, and work, θ_t, are determined by the budget constraint $c_t \leq w(h_t)\theta_t$ and the time constraint $\theta_t + c_t + e_t \leq \bar{\theta}$. Knowing that both constraints will always be binding, we can combine them, getting

$$\text{(A1)} \quad c_t = w(h_t)\theta_t = w(h_t)(\bar{\theta} - e_t - c_t) = \frac{w(h_t)(\bar{\theta}-e_t)}{1+w(h_t)}$$

and the utility of the agent at date *t* may be written as:

$$\bar{u}(h_t, e_t) = u\left(\frac{w(h_t)(\bar{\theta} - e_t)}{1 + w(h_t)}\right)$$

Then, the agent's optimal choice is the solution to the dynamic problem:

$$\max_{e_t} \int_0^T e^{-\rho t}\, u\left(\frac{w(h_t)(\bar{\theta} - e_t)}{1 + w(h_t)}\right) dt$$

where the control variable, e_t, meets the constraint $0 \leq e_t \leq \bar{\theta}$ and the state variable measuring human capital at time *t*, h_t, follows the movement equation:

$$\dot{h}_t = a\, max(e_t - \varepsilon, 0)$$

There is no terminal condition. The current value Lagrangian of this problem is:

$$\mathcal{L} = u\left(\frac{w(h_t)(\bar{\theta} - e_t)}{1 + w(h_t)}\right) + \lambda_t a\, max(e_t - \varepsilon, 0) + \mu_t^0 e_t + \mu_t^1(\bar{\theta} - e_t)$$

where λ_t is the cofactor associated to the movement equation, μ_t^0 is the Lagrange multiplier associated to the constraint $0 \leq e_t$, and μ_t^1 is the Lagrange multiplier associated to the constraint $e_t \leq \bar{\theta}$.
Following the Maximum Principle, the conditions for an optimum are:

$$\text{(A2)} \quad \frac{\partial \mathcal{L}}{\partial e_t} = -\frac{w(h_t)}{1+w(h_t)} u'(c_t) + \lambda_t a(e_t - \varepsilon) + \mu_t^0 - \mu_t^1 = 0$$

$$\text{(A3)} \quad \dot{\lambda}_t - \rho\lambda_t = -\frac{\partial \mathcal{L}}{\partial h_t} = -\frac{(\bar{\theta}-e_t)w\prime(h_t)}{(1+w(h_t))^2} u'(c_t)$$

where $(e_t - \varepsilon) = 0$ if $e_t - \varepsilon \leq 0$ and $(e_t - \varepsilon) = 1$ if $e_t - \varepsilon > 0$. We also have the transversality condition:

$$\lambda_T = 0$$

Note that, if $e_t < \varepsilon$, then $\mu_t^1 = 0$ and $(e_t - \varepsilon) = 0$, so that (A2) becomes

$$\mu_t^0 = \frac{w(h_t)}{1 + w(h_t)} u'(c_t) > 0$$

which implies that no time is allocated to informal education, $e_t = 0$, and, as a consequence no human capital is accumulated, then $\dot{h}_t = 0$. But $\dot{h}_t = 0$ implies that h_t does not change and then, with an invariant stock of human capital, the agent always takes the same decision. Moreover, the terminal condition $\lambda_T = 0$ also implies $\mu_t^0 > 0$ and then $e_t = 0$ or $e_t = \varepsilon$.

If $\varepsilon < e_t < \bar{\theta}$, then $\mu_t^0 = \mu_t^1 = 0$, so that (A2) becomes:

$$\text{(A4)} \quad \lambda_t = \frac{w(h_t)/a}{1+w(h_t)} u'(c_t)$$

and then, calculating the log derivative with respect to time and using the movement equation:

$$\frac{\dot{\lambda}_t}{\lambda_t} = \frac{w'(h_t)}{w(h_t)\big(1 + w(h_t)\big)} \dot{h}_t + \frac{c_t u''(c_t)}{u'(c_t)} \frac{\dot{c}_t}{c_t} = \frac{(e_t - \varepsilon) a w'(h_t)}{w(h_t)\big(1 + w(h_t)\big)} - \eta(c_t) \frac{\dot{c}_t}{c_t}$$

where $-\eta(c_t) = -c_t u''(c_t)/u'(c_t) > 0$. Using (A1), we get:

$$\frac{\dot{c}_t}{c_t} = \frac{w'(h_t)}{w(h_t)\big(1 + w(h_t)\big)} \dot{h}_t - \frac{\dot{e}_t}{\bar{\theta} - e_t} = \frac{(e_t - \varepsilon) a w'(h_t)}{w(h_t)\big(1 + w(h_t)\big)} - \frac{\dot{e}_t}{\bar{\theta} - e_t}$$

so that:

$$\text{(A5)} \quad \frac{\dot{\lambda}_t}{\lambda_t} = \frac{\big(1-\eta(c_t)\big) a w\prime(h_t)(e_t-\varepsilon)}{w(h_t)\big(1+w(h_t)\big)} + \frac{\eta(c_t)}{\bar{\theta}-e_t} \dot{e}_t$$

Let us now rewrite (A3) as:

$$\dot{\lambda}_t - \rho\lambda_t = -\frac{(\bar{\theta} - e_t) w'(h_t)}{\big(1 + w(h_t)\big)^2} u'(c_t) = -\lambda_t \frac{(\bar{\theta} - e_t) a w'(h_t)}{w(h_t)\big(1 + w(h_t)\big)}$$

And then, combining with (A4):

$$\text{(A6)} \quad \frac{\dot{\lambda}_t}{\lambda_t} = \rho - \frac{\big(\bar{\theta}-e_t\big) a w\prime(h_t)}{w(h_t)\big(1+w(h_t)\big)}$$

so that, combining (A5) and (A6) we obtain the equation defining the optimal trajectory for the informal education variable:

$$\text{(A7)}\quad \dot{e}_t = \frac{\bar{\theta}-e_t}{\eta(c_t)}\left[\rho - \frac{\left[\bar{\theta}-\varepsilon-\eta(c_t)(e_t-\varepsilon)\right]aw\prime(h_t)}{w(h_t)\left(1+w(h_t)\right)}\right]$$

Along a trajectory (h_t, e_t) starting from the initial level of human capital, h_0, and the initial choice of informal education, e_0, we have:

$$\text{(A8)}\quad \frac{de_t}{dh_t} = \frac{\dot{e}_t}{\dot{h}_t} = \frac{\dot{e}_t}{a(e_t-\varepsilon)} = \frac{\bar{\theta}-e_t}{\eta(c_t)(e_t-\varepsilon)}\left[\frac{\rho}{a} - \frac{\left[\bar{\theta}-\varepsilon-\eta(c_t)(e_t-\varepsilon)\right]w\prime(h_t)}{w(h_t)\left(1+w(h_t)\right)}\right]$$

Then, knowing that $\eta(c_t) > 0$ and $e_t \leq \bar{\theta}$:

$$\frac{de_t}{dh_t} = 0 \Leftrightarrow \dot{e}_t = 0 \Leftrightarrow\ e_t = \bar{\theta} \text{ or } e_t = Z(h_t)$$

$$\frac{de_t}{dh_t} \gtreqless 0 \Leftrightarrow \dot{e}_t \gtreqless 0 \Leftrightarrow\ e_t < \bar{\theta} \text{ and } e_t \gtreqless Z(h_t)$$

with

$$\text{(A9)}\quad Z(h_t) = \bar{\theta} + \frac{\left(1-\eta(c_t)\right)\left(\bar{\theta}-\varepsilon\right)}{\eta(c_t)} - \frac{\rho w(h_t)\left(1+w(h_t)\right)}{a\eta(c_t)w'(h_t)}$$

Let us now focus on the iso-elastic case, with $\eta(c_t) = \eta \in [0,1]$ and $w(h_t) = (h_t)^\gamma$ with $\gamma \in [0,1]$. Equations (A7), (A8) and (A9) can be re-written as:

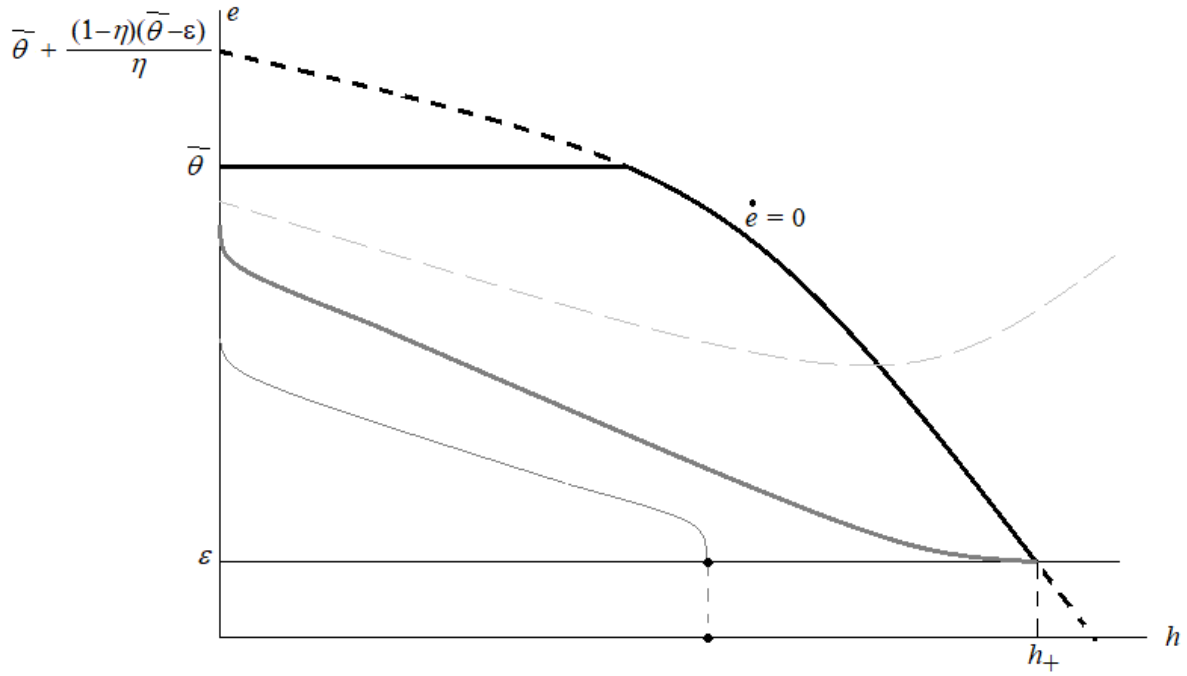
$$\text{(A7.1)}\quad \dot{e}_t = \frac{\bar{\theta}-e_t}{\eta}\left[\rho - \frac{\left[\bar{\theta}-\varepsilon-\eta(e_t-\varepsilon)\right]a\gamma}{h_t(1+(h_t)^\gamma)}\right]$$

$$\text{(A8.1)}\quad \frac{de_t}{dh_t} = \frac{\bar{\theta}-e_t}{\eta(e_t-\varepsilon)}\left[\frac{\rho}{a} - \frac{\left[\bar{\theta}-\varepsilon-\eta(e_t-\varepsilon)\right]\gamma}{h_t(1+(h_t)^\gamma)}\right]$$

$$\text{(A9.1)}\quad Z(h_t) = \bar{\theta} + \frac{(1-\eta)\left(\bar{\theta}-\varepsilon\right)}{\eta} - \frac{\rho h_t(1+(h_t)^\gamma)}{a\eta\gamma}$$

The dynamics of the agent's choice are represented in *Figure 1*.

Figure 1. Dynamics of the agent's choice



The black thick curve represents the highest possible trajectory of investment in informal education where we have $\dot{e}_t = 0$. This curve has two parts: a horizontal part, corresponding to the time constraint, $e_t = \bar{\theta}$, where the agent allocates all the available time to informal education and a decreasing part, corresponding to $e_t = Z(h_t)$. This line crosses the horizontal line $e_t = \varepsilon$ —that is the level of investment in informal education below which human capital accumulation stops—at a threshold level of human capital equal to $h_t = h^+$; for any level of initial human capital $h_t > h^+$, agents will never invest in informal education. For meeting the transversality condition, a trajectory must end on the horizontal axis, knowing that if, at some $\tau < T$, $e_\tau = \varepsilon$, then $e_t = 0$ for every $t \in]\tau, T]$. This rules out all the trajectories that are above the curve $\dot{e}_t = 0$, as along these trajectories e_t increases and then moves away from the horizontal axis. This also rules out the trajectories that are above the thick grey curve, which is the trajectory crossing the intersection of the curve $\dot{e}_t = 0$ at $h_t = h^+$, as these trajectories cross the curve $\dot{e}_t = 0$ and then end with e_t increasing (an example is the thin dotted grey line). A typical trajectory has the shape given by the thin grey line. If the agent's human capital is not too high ($h_t < h^+$), the agent starts with a time devoted to informal education $e_t > \varepsilon$. Then, the time devoted to education decreases along the trajectory until $e_t = \varepsilon$; at that time, the agent jumps to $e_t = 0$ until the end of her life. The agent chooses the highest possible trajectory which implies that, if the life is not too long, she ends at $e_T = \varepsilon$. If her lifetime is longer, the agent chooses the limit trajectory and, at some age $< T$, we have $e_t = \varepsilon$ and $h_t = h^+$. Then, for the end of her life, $e_t = 0$ and the agent does not have informal education.

Derivatives

The signs are derived under the assumption that $\dot{e}_t < 0$ and in the isoelastic case

Derivatives with respect to h_t:

$$\frac{\partial \dot{e}_t}{\partial h_t} = \frac{\bar{\theta} - e_t}{\eta} \frac{[\bar{\theta} - \varepsilon - \eta(e_t - \varepsilon)]\gamma(1 + (1+\gamma)(h_t)^\gamma)}{[h_t(1 + (h_t)^\gamma)]^2} > 0$$

$$\frac{\partial}{\partial h_t}\left(\frac{de_t}{dh_t}\right) = \frac{1}{a(e_t-\varepsilon)}\frac{\partial \dot{e}_t}{\partial h_t} > 0$$

Derivatives with respect to e_t:

$$\frac{\partial \dot{e}_t}{\partial e_t} = \frac{\bar{\theta}-e_t}{\eta}\frac{\eta a\gamma}{h_t(1+(h_t)^\gamma)} - \frac{1}{\eta}\left[\rho - \frac{[\bar{\theta}-\varepsilon-\eta(e_t-\varepsilon)]a\gamma}{h_t(1+(h_t)^\gamma)}\right] > 0$$

$$\frac{\partial}{\partial e_t}\left(\frac{de_t}{dh_t}\right) = \frac{1}{a(e_t-\varepsilon)}\frac{\partial \dot{e}_t}{\partial e_t} - \frac{\dot{e}_t}{a(e_t-\varepsilon)^2} > 0$$

Impact of a change in *a*

$$\frac{\partial \dot{e}_t}{\partial a} = -\frac{\bar{\theta}-e_t}{\eta}\frac{[\bar{\theta}-\varepsilon-\eta(e_t-\varepsilon)]\gamma}{h_t(1+(h_t)^\gamma)} < 0$$

$$\frac{\partial}{\partial a}\left(\frac{de_t}{dh_t}\right) = \frac{1}{a(e_t-\varepsilon)}\frac{\partial \dot{e}_t}{\partial a} - \frac{\dot{e}_t}{a^2(e_t-\varepsilon)} = -\frac{\rho}{a}\frac{\bar{\theta}-e_t}{\eta a(e_t-\varepsilon)} < 0$$

If a increases, then the slope de_t/dh_t of every trajectory is more negative implying that, for the same starting point (h_0, e_0), the new trajectory is below the old one. Consequently, for every level h_t of human capital, e_t is lower (or, reciprocally, for every e_t, the value of h_t on the trajectory is lower). The direct effect of an increase in a on $\dot{e}_t$ is negative and, h_t being lower and $\partial \dot{e}_t/\partial h_t > 0$, the indirect effect is also negative. Along the new trajectory, e_t decreases at a higher speed ($-\dot{e}_t > 0$ is higher) and the new trajectory takes less time. Then, for reaching the target $e_T = \varepsilon$, the agent starts from a higher value of e_0.

Impact of a change in $\bar{\theta}$:

$$\frac{\partial \dot{e}_t}{\partial \bar{\theta}} = \frac{1}{\eta}\left[\rho - \frac{[\bar{\theta}-\varepsilon-\eta(e_t-\varepsilon)]a\gamma}{h_t(1+(h_t)^\gamma)}\right] - \frac{\bar{\theta}-e_t}{\eta}\frac{a\gamma}{h_t(1+(h_t)^\gamma)} < 0$$

$$\frac{\partial}{\partial \bar{\theta}}\left(\frac{de_t}{dh_t}\right) = \frac{1}{a(e_t-\varepsilon)}\frac{\partial \dot{e}_t}{\partial \bar{\theta}} < 0$$

If $\bar{\theta}$ increases, then the slope de_t/dh_t of every trajectory is more negative implying that, for the same starting point (h_0, e_0), the new trajectory is below the old one. Consequently, for every level h_t of human capital, e_t is lower (or, reciprocally, for every e_t, the value of h_t on the trajectory is lower). Then, the higher value of $\bar{\theta}$ implies a more negative value of $\dot{e}_t$, both directly because $\partial \dot{e}_t/\partial \bar{\theta} < 0$ and indirectly because h_t is lower and $\partial \dot{e}_t/\partial h_t > 0$. Along the new trajectory, e_t decreases at a higher speed ($-\dot{e}_t > 0$ is higher) and the new trajectory takes less time. Then, for reaching the target $e_T = \varepsilon$, the agent starts from a higher value of e_0.

Impact of a change in ε:

$$\frac{\partial \dot{e}_t}{\partial \varepsilon} = \frac{\bar{\theta}-e_t}{\eta}\frac{(1-\eta)a\gamma}{h_t(1+(h_t)^\gamma)} > 0$$

$$\frac{\partial}{\partial \varepsilon}\left(\frac{de_t}{dh_t}\right) = \frac{1}{a(e_t-\varepsilon)}\frac{\partial \dot{e}_t}{\partial \varepsilon} + \frac{\dot{e}_t}{a(e_t-\varepsilon)^2} = \frac{\bar{\theta}-e_t}{\eta(e_t-\varepsilon)^2}\left[\frac{\rho}{a} - \frac{(\bar{\theta}-e_t)\gamma}{h_t(1+(h_t)^\gamma)}\right] < 0$$

If ε increases, then the slope de_t/dh_t of every trajectory is more negative implying that, for the same starting point (h_0, e_0), the new trajectory is below the old one. Consequently, for every level h_t of human capital, e_t is lower (or, reciprocally, for every e_t, the value of h_t on the trajectory is lower). The direct effect of an increase in ε on $\dot{e}_t$ is positive, but h_t being lower and $\partial \dot{e}_t/\partial h_t < 0$, there a positive indirect effect. Then, we cannot tell whether the new trajectory takes more or less time than the new one and the impact of a on e_t is ambiguous.

Impact of a change in ρ:

$$\frac{\partial \dot{e}_t}{\partial \rho} = \frac{\bar{\theta}-e_t}{\eta} > 0$$

$$\frac{\partial}{\partial \rho}\left(\frac{de_t}{dh_t}\right) = \frac{\bar{\theta}-e_t}{\eta a(e_t-\varepsilon)} > 0$$

If ρ increases, then the slope de_t/dh_t of every trajectory is less negative implying that, for the same starting point (h_0, e_0), the new trajectory is above the old one. Consequently, for every level h_t of human capital, e_t is higher (or, reciprocally, for every e_t, the value of h_t on the trajectory is higher). Then, the higher value of ρ implies a less negative value of $\dot{e}_t$, both directly because $\partial \dot{e}_t/\partial \rho > 0$ and indirectly because h_t is higher and $\partial \dot{e}_t/\partial h_t > 0$. Along the new trajectory, e_t decreases at a lower speed ($-\dot{e}_t < 0$ is higher) and the new trajectory takes more time. Then, for reaching the target $e_T = \varepsilon$, the agent starts from a lower value of e_0.

Appendix 2

Table 2A. Descriptive statistics of variables used in the estimation

	Immigrants		**Natives**	
VARIABLES	Mean	St. Error	Mean	St. Error
Age	46.4	0.12	48.7	0.054
Female	0.61	0.003	0.61	0.001
Married	0.53	0.004	0.42	0.001
No children	0.51	0.004	0.60	0.001
Children of age 0-2	0.13	0.002	0.1	0.001
Children of age 3-5	0.16	0.003	0.12	0.001
Children of age 6-12	0.29	0.004	0.24	0.001
Children of age 13-17	0.16	0.003	0.13	0.001
Illiterate	0.01	0.001	0.0006	0.000
Elementary	0.036	0.001	0.002	0.000
Middle school	0.12	0.002	0.025	0.000
Secondary	0.50	0.004	0.64	0.001
Degree	0.187	0.003	0.21	0.001
Postgraduate	0.14	0.003	0.12	0.001
Employed	0.63	0.004	0.62	0.001
Unemployed	0.05	0.002	0.042	0.000
Not in labor force	0.32	0.004	0.33	0.001
Observations	**24.865**		**145.977**	

Source: ATUS data (2003–15)

Table 2B Definition of informal education

1. Extracurricular club activities (category activity examples)	
Attending:	**Participating and practicing:**
American Field Service activities, including meetings;	Academic club activities, including meetings
Key Club activities, including meetings	Chess club activities, including meetings
Language club activities	Debate club competition
Math club activities	
National Honor Society activities	
Science club activities	
2. Taking class for personal interest (category activity examples)	
Attending:	**Talking:**
Sunday school	To classmates
Dance class (personal interest)	To teacher
Prenatal/childcare classes (personal interest)	
Taking:	
Car maintenance/repair class	Driver's education
Cooking class	Driving lessons
Financial planning class	Music/voice lessons
Massage class	On-line course
Pottery class	Parenting class

Table 2B Definition of informal education (continued)

Retirement planning seminar	Personal development classes
Sewing class	Photography class
Wine appreciation class	Self-defense class
Academic class	**Cardiopulmonary Resuscitation (CPR),**
Art, craft, hobby, recreational course	first aid class
3. Research or homework for class for personal interest (category of activities)	
Attending study group	Reading
Listening to language CD	Reading/sending e-mail
Organizing notes	Studying
4. Other activities for personal interest (category of activities)	
Preparing and studying for: SAT; GMAT; GRE; LSAT; CPA exam; English for personal interest (2015)	

Table 2C Description of the variables

VARIABLES	*Definition*	*Source*
Dependent variables		
Y_{ij}	Dummy variable equal to 1 if the respondent has spent a positive amount of time in informal education, and 0 otherwise.	ATUS 2003–15
$InformalEdu_{ij}$	Amount of time (in minutes) spent in informal education.	-//-
Explanatory and control variables		
$ForeignBorn_{ij}$	Dummy equal to 1 if the respondent was born abroad, 0 otherwise.	CPS
Age	Age in years	-//-
Age squared	The square of age.	-//-
Female	Dummy equal to 1 if the respondent is female, 0 otherwise.	-//-
Married	Dummy equal to 1 if the respondent is married, 0 otherwise.	-//-
No children, children 0-2 years, children 3-5 years, children 6-12 years, children 13-17 years	5 dummy variables equal to 1 if the respondent has a child in these age groups, 0 otherwise.	-//-
Illiterate, Elementary, Middle, Secondary, Degree, Post graduate	6 dummy variables for each of the educational level specified.	-//-
Holiday	Dummy equal to 1 if the diary day is (Sunday, New Year's Day, Easter, Memorial Day, 4th of July or Christmas), 0 otherwise.	ATUS 2003–15

Table 2C Description of the variables (continued)

Employed	In the reference week, worked at least 1 hour as a paid employee or self-employed. It also includes those in job but not at work in the reference week and the unpaid family workers.	CPS
Unemployed	Individual available for work at the reference week and those making an effort to find a job in the 3 weeks preceding the reference week.	-//-
Not in labor force	Individual that had not actively looked for a job in the 3 weeks preceding the reference week.	-//-