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Abstract*

Birth registration is essential to guarantee a child's right to an identity. Without proper documentation of their identity, children have limited access to health, education and social assistance, laying the foundation for lifelong exclusion. Geographic distance to registration facilities is often cited as a significant barrier in qualitative surveys. Using Global Positioning System (GPS) data, this paper quantifies the impact of distance on birth registration in Bolivia, the Dominican Republic and Peru. The results suggest that increasing the distance to the nearest registry office by 25 kilometers is associated with a 4 percentage point increase in the probability of not registering a child's birth in Bolivia, and 12 percentage points in the Dominican Republic. These effects are as or more important than other socioeconomic characteristics that also affect birth registration, such as maternal education levels and the ability to deliver in a health center. In Peru, distance did not appear to be statistically significant, in line with both the lowest percentage of unregistered births and more even geographic distribution of access to civil registries than Bolivia and the Dominican Republic.

JEL codes: O12, R12, R20

Keywords: global positioning systems, birth registration, civil registries, distance

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Table of Abbreviations and Acronyms

CESDEM	Centro de Estudios Sociales y Demográficos (Center for Demographic Studies)
DHS	Demographic and Health Surveys
GIS	Geographic Information System
GLM	Generalized Linear Model
GPS	Global Positioning System
INE	Instituto Nacional de Estadística, Ministerio de Salud y Deportes (National Institute of Statistics, Ministry of Health and Sports)
INEI	Instituto Nacional de Estadística e Informática (National Institute of Statistics and Informatics)
LAC	Latin America and the Caribbean
MICS	Multiple Indicator Cluster Surveys
NGA	National Geospatial-Intelligence Agency
OAS	Organization of American States
OLS	Ordinary Least Squares
PCA	Principal Components Analysis
RENIEC	Registro Nacional de Identificación y Estado Civil de Peru (National Registry of Identification and Civil Status)
SNRC	Servicio Nacional de Registro Civil (National Civil Registration Service)
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WDI	World Bank Development Indicators

Introduction

Birth registration, which is legal proof of a child's existence and nationality, is considered a fundamental human right according to the Convention on the Rights of the Child (1989). Birth certificates are not the only documents of legal identification, but they are often needed for requesting other documents of legal identification (e.g., national identity cards and passports). Hence, studying the under-registration of births is the first step in understanding the causes of lack of general legal identification.

Those who lack documents of legal identification could be at greater risk of lifelong exclusion. In many countries, identity documents are required to access benefits such as school diplomas, health services, conditional cash transfers, pensions, banking services, civil rights, adoption, divorce, marriage and inheritance. At the same time, if governments lack accurate information about their citizenry, their capacity to improve socioeconomic conditions may be undermined. Any institution that embarks on a campaign to universalize opportunities will face considerable obstacles if they cannot identify disadvantaged individuals because those individuals lack documents of legal identification. Hence, understanding and quantifying the causes and consequences of lack of documents of identification is crucial for sound public policy.

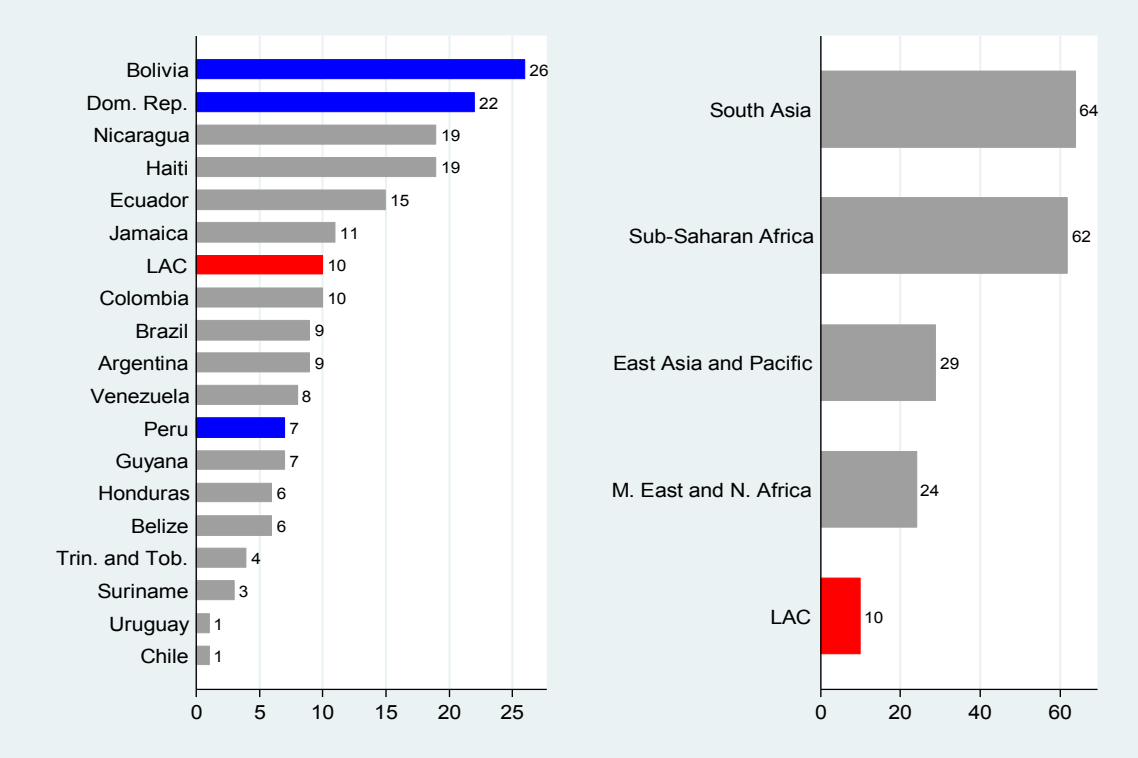
According to UNICEF (2010), 10 percent of children under the age of five live without a birth certificate in LAC. This compares favorably with other regions of the world, such as Sub-Saharan Africa and South Asia, where over 60 percent of the children do not have a birth certificate (see Figure 1 on the following page). But there is considerable heterogeneity across countries in the LAC region. Unregistered births range from over 20 percent in Bolivia and the Dominican Republic to under 7 percent in Chile and Peru.

There could be a number of reasons for unregistered births. The empirical literature finds that the maternal education levels, whether or not the child is delivered at a health facility, age of the child, household income and urban location all affect birth registration (UNICEF, 2005; Duryea, Olgiati and Stone, 2006; Castro and Rud, 2011). Qualitative studies also show that the distance from households to registration facilities is widely perceived as one of the most important deterrents to registration (Bracamontes and Ordonez, 2006; Harbitz and Tamargo,

2009). Better knowledge of the impact of distance on under-registration could raise awareness that may improve access to civil registries. Yet, to this date, this impact has not been quantified.

Using GPS-collected data, this paper examines how the distance from households to civil registries affects the probability of birth registration of children aged 0 to 4 in Bolivia, the Dominican Republic and Peru. These three countries cover a wide spectrum of experience in terms of birth registration in LAC. We focus on physical access to civil registries because distance and location are crucial determinants of many households' decisions. Distance to the civil registry may affect the probability of registration because of travel costs, access to information about the location of civil registries, procedures involved and perceived benefits of registration.

Figure 1. Percentage of Children Without a Birth Certificate, Age 0–4, 2000–2009*



** Refers to most recent year available.*
Source: UNICEF global databases 2010, from MICS, DHS and other national surveys.

The distance to the nearest registration center is a significant barrier to birth registration in Bolivia and the Dominican Republic. The results suggest that increasing the distance to the nearest registry office by 25 kilometers is associated with a 4 percentage point increase in the probability of not registering a child's birth in Bolivia, and 12 percentage points in the Dominican Republic. Distance is as or more important than socioeconomic characteristics also associated with lower probabilities of birth registration, such as poverty, low education of the mother and babies not being delivered in a health facility. For instance, in the Dominican Republic, a reduction in the distance to a registry office of 25 kilometers has an effect on the likelihood of registration equivalent to universalizing secondary education for mothers. However, while reducing the distance to a registry office could be implemented in the short term, universalizing secondary education would take years to achieve. A more equitable distribution of civil registries may hence be a cost-effective way to encourage birth registration in these countries. In Peru, distance did not appear to be a significant determinant, which is consistent with wide coverage of registration facilities across the country and relatively high birth registration rates.

The rest of the paper is organized as follows. It first reviews related literature and examines factors associated with the registration of children's births. The paper then presents the data used and the methodology and potential econometric difficulties, and finally analyzes the results and provides conclusions.

Literature

The literature on access to civil registration is relatively scarce. Empirical studies include UNICEF (2005) for all regions of the world, and Duryea et al. (2006) and Castro and Rud (2011) for LAC. According to Duryea et al. (2006), the probability of a birth registration is affected positively by the level of education of the parents, delivery at a health facility, wealth and the age of the child. On the other hand, birth registration is negatively affected if the parent is single, the mother is a teenager or the household lives in a rural area. Similarly, Castro and Rud (2011) find that under-registration of children is more pervasive in rural areas with low levels of income, where the head of household is relatively less educated and does not possess documents of legal identification. In addition, they find that under-registration is correlated with poor access to public services and programs.

Some research has raised awareness of this issue and searched for practical solutions. For example, using field research based on face-to-face interviews in several LAC countries, Harbitz and Boekle-Giuffrida (2009) document the diversity of challenges faced by those lacking documents of legal identification. Harbitz and Tamargo (2009) offer a qualitative exploration of the factors that contribute to the under-registration of births.

Studies that incorporate GPS data to study the effect of location on economic decisions are similarly rare. Kremer and Miguel (2004) assess the external effects of a de-worming program on schooling in Kenya. Gibson and McKenzie (2007) study how negative experiences of emigrants in Tonga affect employment expectations of potential emigrants to New Zealand. Conley and Udry (2010) analyze spillover effects in the use of a new technology to raise pineapple in Ghana. McKenzie and Sakho (2010) use distances as an instrument for whether or not a firm is registered to pay taxes. One characteristic that all of these studies share is that they use GPS data to measure distance. This literature is growing but remains scarce.

This paper is the first to look at the effect of location on birth under-registration. Hence, this study is unique in two ways. First, it uses data obtained with GPS technology to assess equitability of access to civil registries. Second, it is the first empirical study to look at the impact of distance on under-registration of births. This study also looks at other variables to assess causes of under-registration and controls for socioeconomic determinants.

Determinants of Registration

The calculations for this paper assume that parents compare the benefits and costs of registration when deciding whether to register a child's birth. Under a standard model of economic decision-making, rational parents in full knowledge of the advantages of birth registration would pay the costs of registration when such costs are lower than the value of the perceived benefits. Hence, holding everything else constant, variations in the valuation of benefits and costs could yield different registration rates across households.

There would be numerous micro and macro determinants of the costs and benefits of a household's decision to register a child's birth. At the micro level, we could cite geographic, cultural, economic and psychological factors. Given the micro data used in this study, we were able to consider all micro determinants except psychological factors. A brief description of these factors is offered below.

At the macro level, there are institutional, legislative, normative and political factors. It is elusive for now to study how the underlying mechanisms of macro determinants affect registration. This could be attempted in the future if comprehensive panel data were collected. For this reason, we analyzed each country separately and included fixed effects for each region to account for differences among regions within countries.

Geographic: Households that are in proximity to a registry office may have more information about the importance of registration and of the steps involved. Thus, living in remote areas may affect the perceived benefits, which could vary among households, and may depend on the location of public services such as schools and health centers. Geographic barriers have been mentioned in numerous qualitative studies as one of the main determinants of under-registration (UNICEF, 2005; Bracamontes and Ordonez, 2006; Harbitz and Tamargo, 2009), but there is no quantitative empirical evidence. The goal of this paper is to fill this knowledge gap.

Cultural: There might be several mechanisms through which cultural factors affect decision-making. Indigenous people, for example, may face discrimination and tend to have low levels of income and education (Hall and Patrinos, 2006). Registration could then be another way they are excluded and poverty is perpetuated. Indigenous populations may also face a language barrier since, in the majority of countries, their language is different from the predominant language. We

cannot disregard factors associated with cultural practices that contribute to under-registration, such as giving birth with indigenous rituals, which may restrict access to health facilities.[1] Finally, androcentric practices may mean mothers are more likely to register males in countries with patriarchal predominance, because the males pass on the name of the family. In addition, as found by Dureya et al. (2006), a single mother may refuse to obtain the birth certificate until after the father recognizes the child to avoid social stigma.

Economic: Resources devoted to the registries in the national budget may affect the quality of registration services. Distance to the nearest office could hence be a crude measure of access in cross-country studies. There could also be economic barriers at the individual level. However, each country in this study has legislation granting birth registration for free if done within a certain period of time.[2] Still, costs related to days of work lost, transportation and fees for photocopies, among others, need to be taken into account.

Psychological: These are factors that economists are only beginning to understand and they deviate from the paradigm of full rationality. They may affect how people process information and make their decisions. Hyperbolic discounting, for example, is used to model how humans prefer rewards that arrive sooner rather than later. In the context of registration, if parents fail to associate it with future rewards for their children, they may not be willing to register their children in due time. What could be of concern is that these effects may be exacerbated in the contexts of poverty and exclusion (Bertrand, Mullainathan and Shafir, 2004). Our study does not take into account these factors.

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[1] For example, Bracamontes and Ordonez (2006) document that in Ecuador certain indigenous groups reject the notion of birth in modern health facilities because of ancient cultural practices that worship the placenta, which is associated with the soul of the child.

[2] In Bolivia, Law No 2616 (2003) establishes that registry of the first birth certificate for children aged 0 to 12 and adolescents aged 13 to 18 is free. However, after the age of 18 the cost is 80 Bolivians (approx. US$13). See http://www.oep.org.bo/RegistroCivil/ for more details.
In Peru, the registry of children is free according to Article 48 of Law 29497 of RENIEC and it must be made within three days for those born in hospitals or 30 days for the rest, except for those living in distant areas such as jungles, borderlines or zones of difficult access. For more details see http://www.reniec.gob.pe.
In the Dominican Republic, according to law No 218-07 article 10, registry is free even for those outside the period of registration (within 30 days for urban areas and 60 for others). See http://www.unicef.org/republicadominicana/Ley_No.218-07_amnistia_declaracion_nacimiento.pdf for more details.

Data

With the exception of a few surveys like the Living Standard Measurement Survey of Guatemala and the DHS of some countries, surveys and census rarely include questions on birth registration. For the three Latin American countries studied for this paper—Bolivia, the Dominican Republic and Peru—we use the DHS.[3] These surveys include specific questions related to birth registration of children under five and the geographic position of the households in the survey (GPS data). The combination of GPS and birth registration data make these surveys unique in the region.[4]

The sampling methodology for the surveys is similar across countries. In the first stage, the country is divided into census areas, simply known as clusters or Primary Sampling Units, using the last census available in the country. Then, the data is collected within a randomly selected sub-sample of clusters, each including on average 20 households.[5] Table 1 provides a summary of the surveys, including sample size and period of collection.

Table 1. Summary of Surveys (Demography and Household Surveys, DHS)

	Bolivia	Dominican Republic	Peru
Collected by	INE*	CESDEM*	INEI*
Period	February 2008–June 2008	March 2007–August 2007	December 2003–October 2008
Years	2008	2007	2004–2008
Panel	No	No	No
Number of clusters	1,000	1,419	1,830
Number of clusters with GPS	1,000	1,419	1,409
Mean number of households per cluster	19.5 (min=11, max=22)	22.7 (min=4, max=31)	22.7 (min=7, max=45)
Number of households	19,564	32,431	46,073

* *See table of abbreviations and acronyms on page 2.*
Source: MeasureDHS, NGA, SNRC, Central Electoral Board and RENIEC.

[3] Available at http://www.measuredhs.com
[4] Among LAC countries, the DHS for Haiti also included GPS data but missing information on many other variables considerably reduced the usable number of observations.
[5] Because of the precision of the GPS data, the decision to collect the GPS at the cluster level and not at the household level was necessary to protect the privacy of the interviewed households. In addition, a random error in the GPS latitude/longitude position is included to ensure the respondent confidentiality. See http://measuredhs.com/faq.cfm for more details.

Complete GPS data were available for Bolivia and the Dominican Republic, but not for Peru. For Peru, there were 421 clusters (out of 1,830) for which no GPS data were collected. These missing data could be a problem if regions with a greater number of unregistered births (perhaps remote areas) correspond to those with missing GPS information. Hence, we checked if the sub-sample of the population with GPS had birth registration rates comparable to those of the total sample, including the population without GPS. To do this, we compared the average under-registration rates of the total sample by provinces with the under-registration rates of the sub-sample with GPS. The graph in Appendix 1 shows that both under-registration rates fall along a 45 degree line. The slope of the line is statistically different from one (we did not reject the hypothesis that is different from 0.92). This suggests that the sample for Peru could be slightly biased toward including a sub-sample with under-registration rates that are smaller than the average of the population sample. This sample bias may cause a drop in the statistical significance of the coefficients of a regression of birth registration on distance, but it is not clear how severe this drop might be.

There are two additional problems with information loss in these surveys. The first has to do with the exclusion of children born of mothers who passed away. For Bolivia, the WDI report maternal mortality rates for 2008 of 310 per 100,000 during pregnancy or childbirth. This would leave the children of approximately 310 mothers for every 100,000 children born alive out from the sample.[6] Nevertheless, mortality rates among indigenous people living in isolated areas could be higher (Cordero, Luna and Vattuone, 2010). Hence, higher mortality rates in isolated areas could lead to underestimation of unregistered births. However, this data suggests that mortality rates are too low to be considered a source of sample bias.

The second problem has to do with migration after a child is born, which could reduce the explanatory power of the variable distance. We excluded from the sample the households that moved after a child was born. The percentage of households reporting living in the same house before the child was born is similar in the three countries at approximately 94 percent.

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[6] For the Dominican Republic, it is estimated that 159 mothers died for every 100,000 children. The WDI for Peru did not report maternal mortality rates for the period 2004–2008, but for the year 2000, the national maternal mortality rate was estimated at 185 per 100,000 live births.

We also collected GPS data regarding civil registries in the three countries (Table 2). In the first stage, we obtained the exact address of each civil registry office. Then we used these addresses to obtain their corresponding GPS data, comparing two GPS databases, the first collected by the NGA[7] and the second based on the maps published by Google online. While all the data were collected for the Dominican Republic, we could not find the GPS data for 159 civil registries in Bolivia (8.5 percent of the total) and for 683 civil registries in Peru (16.5 percent of the total). Again, given the lack of precision of data for Peru, it is not clear if the Peruvian sample could be useful to perform inferential analysis of the effect of distance on under-registration of births.

Table 2. Summary of GPS Data of the Civil Registries

	Bolivia		Dominican Republic		Peru	
	Number	%	Number	%	Number	%
Number of registries with GPS data	1,716	91.5	158	100	3,463	83.5
Number of registries missing GPS	159	8.5	0	0	683	16.5
Total number of registries	1,875	100	158	100	4,146	100

Source: SNRC, Central Electoral Board and RENIEC.

Besides distance to the nearest civil registry office, we used a rich set of socio-demographic variables (Tables 3–5). The tables are organized in four groups of characteristics: civil registration offices (distance and computerization), parents, children and household. The Bolivian DHS 2008 and Peruvian 2004–2008 collected new information related to indigenous languages spoken as a first tongue by the parents. Around 40 percent of the parents of the children in our sample speak Quechua, Aymara or other Amerindian languages as a first tongue. For the Dominican Republic, the DHS 2007 asked whether or not the parents were born abroad. About 6 percent of the parents were born in a country other than the Dominican Republic. The surveys also contained information about the level of education of the mother, national identity card of the mother (for the DHS of Dominican Republic and Peru only), civil status, age, gender of the child, season of the year at the moment of birth and household characteristics, such as

[7] The NGA is part of the U.S. Intelligence community and provides support to the Department of National Defense of the United States. See https://www1.nga.mil/Pages/Default.aspx for more details.

wealth and access to public services (e.g., water and electricity). Appendix 2 shows the survey questions about birth certificates and other variables.

Table 3. Summary Statistics for Bolivia, 2008

Variables	(1) N	(2) mean	(3) sd	(4) min	(5) max
Dependent variables					
1 if child does NOT have a birth certificate, 0 otherwise	7,206	0.262	0.429	0	1
Explanatory variables					
Distance to nearest registry in kilometers	7,602	17.22	42.14	0.018	585
Altitude in kilometers	7,206	2.240	1.460	0.11	4.6
Office is computerized	7,206	0.004	0.0611	0	1
Parents' characteristics					
Parents speak Quechua	7,206	0.196	0.397	0	1
Parents speak Aymara	7,206	0.085	0.280	0	1
Parents speak other natural language	7,206	0.008	0.093	0	1
Teenage mother	7,206	0.286	0.452	0	1
Mother lives with partner	7,206	0.873	0.333	0	1
Mother has primary education	7,206	0.522	0.500	0	1
Mother has secondary education	7,206	0.294	0.455	0	1
Mother has more than secondary education	7,206	0.129	0.336	0	1
Child's characteristics					
Child is a girl	7,206	0.487	0.500	0	1
Current age of child	7,206	1.941	1.416	0	4
First born	7,206	0.284	0.451	0	1
Youngest child	7,206	0.755	0.430	0	1
Birth not attended by health specialist	7,206	0.283	0.450	0	1
Child born during rainy season	7,206	0.425	0.494	0	1
Household's characteristics					
Health center far away	7,206	0.260	0.161	0	1
Mother makes financial decisions	7,206	0.117	0.322	0	1
Wealth	7,206	2.693	1.381	1	5
Car or truck	7,206	0.14	0.348	0	1
Household head is male	7,206	0.854	0.353	0	1
Household head's age	7,206	37.10	11.92	16	88
No water or electricity	7,206	0.057	0.232	0	1
Number of people in cluster	7,206	83	15	31	147

Source: DHS 2008, SNRC and NGA.

Table 4. Summary Statistics for the Dominican Republic, 2007

Variables	(1) N	(2) mean	(3) sd	(4) min	(5) max
Dependent variable					
1 if child does NOT have a birth certificate, 0 otherwise	6,870	0.211	0.408	0	1
Explanatory variables					
Distance to nearest registry in kilometers	6,870	5.035	4.265	0.03	28.5
Altitude in kilometers	6,870	0.163	0.219	0	1.4
Parents' characteristics					
Mother has national ID (*cédula de identidad*)	4,016	0.123	0.329	0	1
One parent born abroad	6,870	0.061	0.241	0	1
Teenage mother	6,870	0.084	0.278	0	1
Mother has primary education	6,870	0.445	0.497	0	1
Mother has secondary education	6,870	0.330	0.470	0	1
Mother has more than secondary education	6,870	0.140	0.347	0	1
Child's characteristics					
Child is a girl	6,870	0.479	0.500	0	1
Current age of child	6,870	1.959	1.447	0	4
Birth not attended by health specialist	6,870	0.030	0.172	0	1
First born	6,870	0.290	0.454	0	1
Youngest child	6,870	0.571	0.495	0	1
Child born during rainy season	6,870	0.500	0.500	0	1
Child of household head	6,870	0.073	0.261	0	1
Household's characteristics					
Wealth	6,870	2.331	1.332	1	5
Car or truck	6,870	0.120	0.329	0	1
Health center far away	6870	0.295	0.455	0	1
Mother makes financial decisions	6,870	0.098	0.298	0	1
Household head is male	6,870	0.813	0.390	0	1
Household head's age	6,870	36.90	12.44	16	97
No water or electricity	6,870	0.045	0.207	0	1
Number of people in cluster	6,870	91	15	23	148

Source: DHS 2007, Central Electoral Board and NGA.

Table 5. Summary Statistics for Peru, 2004–2008

Variables	(1) N	(2) mean	(3) sd	(4) min	(5) Max
Dependent Variable					
1 if child does NOT have a birth certificate, 0 otherwise	11,668	0.032	0.175	0	1
Explanatory Variables					
Distance to nearest registry in kilometers	11,668	4.849	6.348	0.034	53.6
Altitude in kilometers	11,668	1.654	1.582	0	4.8
Parents' Characteristics					
Parents speak Quechua	11,668	0.344	0.475	0	1
Parents speak Aymara	11,668	0.0304	0.172	0	1
Parents speak other natural language	11,668	0.0280	0.165	0	1
Teenage mother	11,668	0.0273	0.163	0	1
Mother lives with a partner	11,668	0.893	0.309	0	1
Mother has primary education	11,668	0.412	0.492	0	1
Mother has secondary education	11,668	0.356	0.479	0	1
Mother has tertiary education	11,668	0.177	0.382	0	1
Child's Characteristics					
Child is a girl	11,668	0.130	0.337	0	1
First born	11,668	0.173	0.379	0	1
Youngest child	11,668	0.700	0.458	0	1
Current age of child	11,668	2.101	1.382	0	4
Birth not attended by health specialist	11,668	0.342	0.474	0	1
Household's Characteristics					
Wealth index	11,668	2.790	1.292	1	5
Car or truck	11,668	0.047	0.212	0	1
Household head is male	11,668	0.820	0.337	0	1
Household head's age	11,668	39.23	10.89	16	87
Health center far away	11,668	0.459	0.498	0	1
No water or electricity	11,668	0.082	0.275	0	1
Number of people in cluster	11,668	126	41	31	213

Source: DHS 2004-2008, RENIEC and NGA.

Methodology

We ran several econometric models using as the dependent variable whether the child had a birth certificate or not. The models were run separately for each country to account for administrative, political and legislative differences, as well as any possible unknown country effects. The dichotomous dependent variable takes the value of 1 if the child did NOT have a birth certificate and 0 otherwise. The basic calculation is:

$$NoBirthCert_{ij} = \beta_0 + Distance_{ij}\beta_1 + X_{ij}\beta_2 + \gamma_j + \varepsilon_{ij} \quad (1)$$

where sub-indexes i and j denote household i in region j, respectively. Distance is measured in kilometers from each cluster to the nearest available office (in units of 25 kilometers). X_i is a vector of other controls for every household i, and γ_j is a vector of dummies for each region within countries.

We estimated the equation through ordinary least squares (OLS) as well as a probit model given the dichotomous characteristic of the dependent variable. As robustness checks, we used two alternative definitions of the dependent variable. The first alternative was the proportion of children without birth certificates within the household, which varied between 0 and 1. We used OLS and a generalized linear model (GLM) for fractional response variables, as in Papke and Wooldrige (1996).[8] The GLM specification is more appropriate for a dependent variable that is a proportion since it does not allow for the predicted values to fall outside the 0–1 range. For the second alternative—a dummy coded as 1 if all children within the household lacked a birth certificate and 0 otherwise—we ran OLS and probit econometric models. To calculate the distance from the clusters of households to each available registry office, we used the Haversine formula[9] (first published by Sinnott, 1984). This formula assumes that the Earth is spherical, an assumption appropriate for the locations of the countries in this study.

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[8] To run this econometric specification, in the econometric software STATA 11 the function GLM was used with the options family (binomial) link (logit) and robust.

[9] We use the function globdist (the distance between latitude and longitude coordinates) in STATA, ado written by Kenneth L. Simons. By default, this function uses the radius of the earth at the average latitude in the data. See http://www.rpi.edu/~simonk/ for details.

$$D(x,y) = cos^{-1}\{\sin(lat_x) * \sin(lat_y) + \cos(\text{lat}_x) * \cos(\text{lat}_y) * [\cos(\text{lon}_y - \text{lon}_x)]\} * R \quad (2)$$

where x and y represent any two different places on Earth, and R is the radius of the Earth in kilometers.

The advantages of using geographic coordinates in a study of spatial access are numerous. Many studies that account for distance to public services rely on self-reported distances from household members. These have several potential problems that could affect the quality of the analysis. As discussed in Gibson and McKenzie (2007), self-reported distances might be correlated with the outcomes of interest. Those who use public services more frequently may have a better idea of actual distance than those who rarely use them. Also, self-reported travel time or distances are given in round figures, such as 30 minutes, 1 hour, or 1, 5 or 10 kilometers, and so on, which are less precise than GPS data.

Usually, surveys ask only about the nearest public service within each jurisdiction but forget about those located near the boundaries of the administrative region. Thus, households residing in one administrative region might go to another administrative region if they have a nearer office. For Bolivia and Peru, we calculated the minimum distance from each household to each registry regardless of the administrative region of the civil registry. In the Dominican Republic, the normative procedure establishes that the birth registration must be made within the same jurisdiction where the mother gave birth. Thus, for the Dominican Republic, we calculated the distance to the nearest civil registry within the same department where the mother gave birth.

Despite these advantages, GPS-measured distance likely underestimated the travel distance to a registry office. This measurement error is likely exacerbated in the Andean region where the terrain is more rugged than in the Dominican Republic. For this reason, we included the altitude of the cluster as a proxy for the shape of the landscape. Another disadvantage is that we cannot control for means of transportation. In this sense, our results could be biased if two towns are equidistant from the nearest civil registry office but one is served by public transportation and the other is not. For this, we included fixed effects at the smallest administrative regional jurisdiction we could find (provinces in Bolivia and Peru; district

municipalities in the Dominican Republic).[10] Additionally, we added an indicator of whether the child was born during the rainy season in Bolivia and the Dominican Republic. Usually, in developing countries, roads and highways are considerably affected by rain, making some of them usable only during the dry season. In Peru, the variety of climates makes it difficult to control for a suitable proxy of weather. The fixed effects at the regional level could help capture these unobservable factors.

We also collected data about other characteristics of the registry offices, such as computerization of procedures. It is reasonable to expect people to prefer registries that are modernized even if they are more distant than other offices. For Bolivia, we were able to calculate the distance to the nearest computerized registry office. In this manner, aspects of the quality of the registration services are taken into account.

With Geographic Information System (GIS)[11] files and GPS data we were able to draw maps and to locate registries and clusters of households with great precision. This allowed us to visualize the positions of both registries and households, revealing aspects of optimal locations and the equitability of access to registration services.

The regressions included a host of socioeconomic factors at the individual and household level. In addition to those analyzed in Duryea et al. (2006), we explored whether ethnic background was a potential determinant of under-registration. For example, while in Bolivia and Peru the problem of under-registration may be related to cultural or socioeconomic factors specific to indigenous people, in the Dominican Republic, the main challenge may relate to children of Haitian origin.

To account for cultural factors associated with discrimination, prejudice or language barriers, we included indicators of ethnicity[12] for Bolivia and Peru. For Amerindian descent, we

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[10] Another determinant that was not taken into account was mobile registration campaigns in the three countries. The effectiveness of such campaigns is an issue that requires further investigation.

[11] GIS are format standard files used to encode geographic information such as elevation lines, geographic objects and contour lines of administrative boundaries, among others. These are useful to graphically present multiple layers of data to inform policy-makers. See www.diva-gis.org for details.

[12] Although there is no consensus over who should be considered an indigenous person, the most accepted definition relates to the language learned during childhood. This may overestimate ethnicity among some indigenous groups, such as the Guaranis and some Quechuan speakers in Cochabamba, who do not self-identify as indigenous. Similar results were found when we considered if only one parent spoke an indigenous language.

used whether both parents spoke Quechua, Aymara or other indigenous tongue as a first language as a dummy variable.[13] For the Dominican Republic, particular attention was paid to the children of Haitian origin. Because of a diversity of factors that influence migration, there is a significant unregulated flow of Haitians into the Dominican Republic. While there are no reliable estimates of the number of children of Haitian origin in the Dominican Republic, the number could be between 0.5 million and 1.5 million (Ferguson, 2003). To take this into account, we included a dummy variable equal to 1 if one of the parents was born abroad and 0 otherwise.

For the Dominican Republic and Peru, we included a variable of whether or not the mother had a national identity card, but unfortunately the Bolivian DHS 2008 did not contain this information. Stringent regulations to request birth registration could be a barrier. One document that is often required is the national identity card of the parent or of the de facto custodian. Consequently, it is harder to register a child if the parent also lacks legal documents of identification. In this sense, lack of legal identification can become a self-perpetuating problem. The legal requirements for the countries considered in this study are provided in Appendix 3.

We controlled for household wealth using principal components analysis (PCA). PCA allows a single variable to be created from a vector of indicators of assets owned by a household. This variable is used regularly as a proxy for income or expenditures (Filmer and Pritchett, 2001). In addition, a variable related to a woman's empowerment was used to see if there is an association between the predominance of a female decision-maker and birth registration. The variable was coded as 1 if the mother alone decided how money was spent in the household and 0 otherwise. A proxy for perceived benefits was used to control for benefits accrued from the state. The variable was a dummy coded as 1 if the respondent of the survey answered that they were not using health services because they were far away and 0 otherwise.

[13] We included the interaction of ethnicity with wealth, distance and education, but the coefficients were not significant and thus we did not report the results.

Is Distance to the Civil Registry Endogenous?

Two situations that could affect the distance of a household from civil registries relate to either a family's choice or how governments locate registry offices. Both situations could make the causation to go from under-registration of births to distance making distance endogenous. A family could choose to reside near a civil registry office once a child is born to facilitate the registration process. We believe this is improbable because registration happens once in the lifetime of an individual. Second, which we believe is more likely, the location of civil registries could be chosen based on the need to serve areas with higher-than-average under-registration rates. In this scenario, the coefficient of a regression of registration on distance could be biased toward zero. Nonetheless, according to the regulations governing civil registries, the location of the registry offices is based on the size of the population served. In Bolivia, a civil registry is created when an area reaches a population of more than 2,000 people, and more than one is created where the population exceeds 10,000 inhabitants (see Article 10 of the legislation of civil registry offices in Bolivia).[14] Offices are therefore distributed to maximize coverage. The regulations do not mention registration rates as a factor in determining the location of a registry office. In addition, the maps in Figures 3 through 5 suggest that registry offices are located in densely populated areas.

We believe that the most likely source of econometric misspecification could be the omission of relevant variables. If the distance to the civil registry office is capturing distance to public services, people may choose not to register a child because of a lack of government services in the area rather than because the registry office is far. If this is the case, we could be attributing the effect of distance to the registry office and not to the lack of public services.

To avoid this possible misspecification, we included variables that seek to control for access to public services. The first is whether or not the mother gave birth at a health facility; the other is whether or not the household considered the health facility to be far away. Health access is the most vital public service for children under five, and often health facilities help families

[14] The regulations governing civil registries can be found at the following websites:
Bolivia: http://www.oep.org.bo/RegistroCivil
Dominican Republic: http://www.transparencia.jce.gob.do/Default.aspx?TabID=237&xsfid=160
Peru: http://www.reniec.gob.pe/portal/intro.htm

with registration procedures. It is therefore critical to control for this factor. Unfortunately, the DHS does not include information about the proximity of schools, which would be important for mothers who are long-term planners (i.e., a mother may choose not to register a child if the school is far away). However, we were able to control for access to public utilities such as water and electricity, which have been used in the literature as explanatory variables of school access (Cox-Edwards and Ureta, 2003; Hanson and Woodruff, 2003). We also added a measure of population density calculated as the number of people within the cluster, presuming people living in more populated areas have access to better infrastructure and public services. Further, we tested other population density controls, such as the number of people within a 4, 10, 15, 20 and 25 kilometer radius from the cluster, all with similar results.

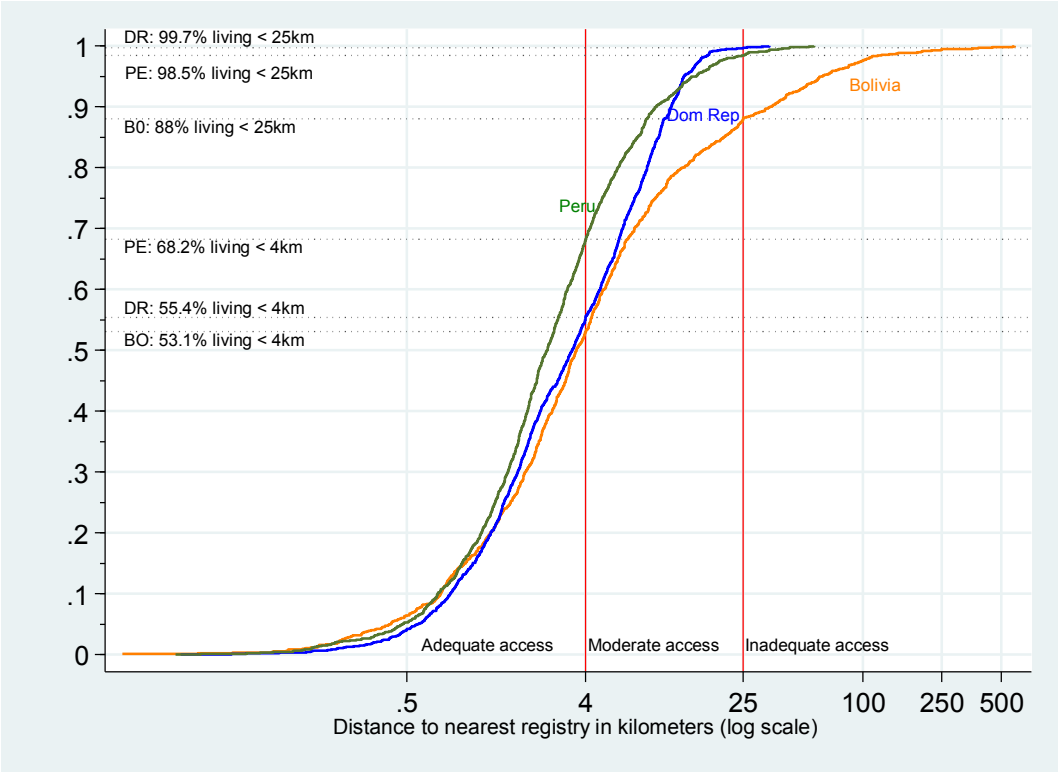
Results

As a first exploration of access to registration services, we constructed the cumulative distribution functions of the minimum distance from each cluster of households to a civil registry. Figure 2 reports the proportion of households that live within a certain distance of a civil registry. The figure includes two critical values: 4 and 25 kilometers. These thresholds are not arbitrary; traditionally, they have been used in the field of medical geography as indicators of access to health care facilities (Earickson and Meade, 2000; Rosero-Bixby, 2004). Ignoring means of transportation, if a 4-kilometer walk (8 kilometers round trip) represents a challenge, then the 25-kilometer threshold (50 kilometers round trip) would be a considerable obstacle, taking into account the walking speed of the average human being, which is about 5 kilometers per hour.

These cumulative distribution functions indicate that 68 percent of the population in Peru resides less than 4 kilometers from a civil registry. Thus, the majority of the population did not face a challenge in accessing registration services according to the critical values just described. In the Dominican Republic, this estimate dropped to 55 percent, and in Bolivia, to 53 percent. Birth registration rates rank in the same order. Our hypothesis is that this positive correlation between the rankings of access to registration services and birth registration rates is not a mere coincidence. The figure also suggests that larger countries with populations scattered across a wide area face more difficulties providing coverage than smaller ones. For instance, Bolivia has 11 million people (2010 estimate) living in an area of 1,098,580 square kilometers compared to the Dominican Republic, which had 8 million inhabitants (2010 estimate) living in only

48,442 square kilometers. However, Bolivia has 1,875 civil registries compared to only 158 in the Dominican Republic. Still, with these fewer registration centers, the percentage of people living within a specific distance of a civil registry is larger in the Dominican Republic than in Bolivia almost throughout the whole cumulative distribution.

Figure 2. Cumulative Distribution of Distance

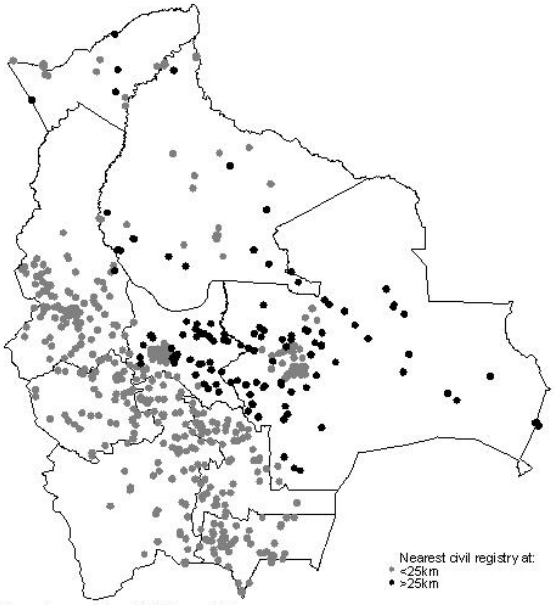


Source: Authors' elaboration based on DHS from Bolivia, the Dominican Republic and Peru and GPS data of civil registry offices.

The maps of Bolivia in Figure 3 show the location of clusters of households and civil registries. The figure reveals that most clusters of households are located in the Andes plateau known as the *altiplano*, a flat highland that extends from the department of La Paz to Tarija. This is also where most of the civil registries are located. In contrast, in Beni, Cochabamba and Santa Cruz, the civil registries seem to be clustered around large cities, leaving vast parts of their territories unattended. Perhaps it is for this reason that Beni, Cochabamba and Santa Cruz exhibit the largest number of households that are positioned at more than 25 kilometers from a civil registry and consequently have the highest proportion of unregistered children.

Figure 3. Bolivia, 2008

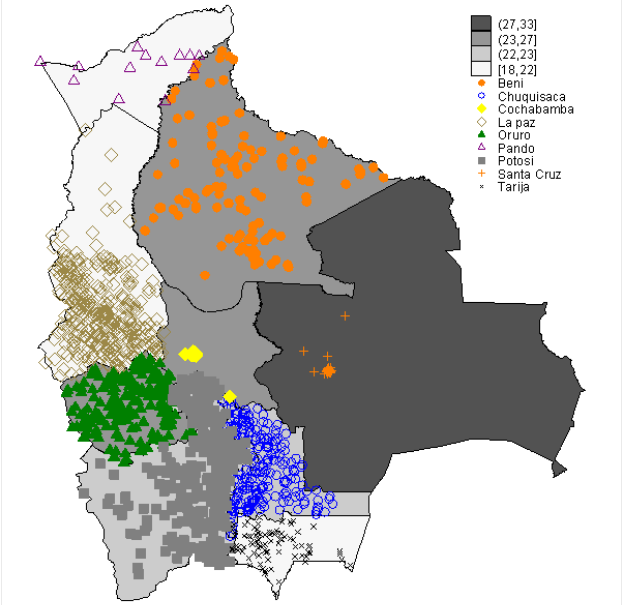
Clusters of Households



Source: DHS 2008.

Civil Registries

Estimated Probabilities (Y=NO birth certificate)

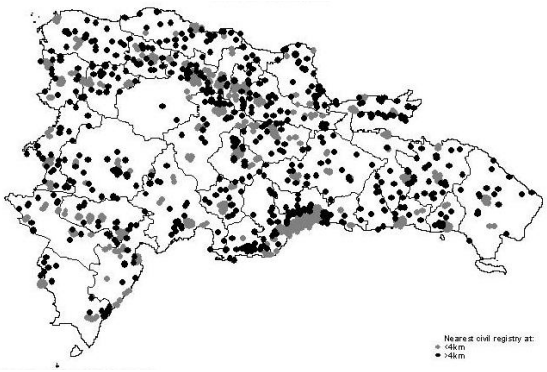


Source: NGA, Google Maps and SNRC.

In contrast, the maps of the Dominican Republic (Figure 4) illustrate a better distribution of the countries' civil registries. This could be the result of more strategic localization of civil registries combined with a more cooperative geography and a smaller national territory. This suggests that the low registration rates in the Dominican Republic might be associated with factors other than the geographic distribution of registration centers. One possibility could be the high number of children of Haitian origin, whose parents lack the documents of identification required to register a child's birth.

Figure 4. Dominican Republic, 2007

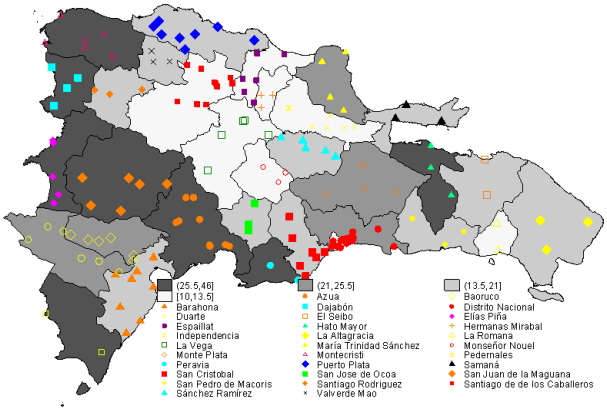
Clusters of Households



Source: DHS 2007.

Civil Registries

Estimated Probabilities (Y=NO birth certificate)



Source: NGA, Google Maps and SNRC.

In addition to a large territory, Peru has the Andes Mountains dividing it into three geographic regions: the arid coast, the jungle and the highlands. Nevertheless, Peru's distribution of civil registries shows that a unique topography and a variety of climates are not insurmountable obstacles to registering a child's birth, since Peru's registration rates are higher than the average for Latin America. Nonetheless, Figure 5 shows that the Peruvian departments with lower registration rates are those located to the east of the Peruvian Andes: Loreto, Madre de Dios and Ucayali. Families living in these departments might have less contact with the more densely populated pacific coast in Peru and thus the state may be less present.

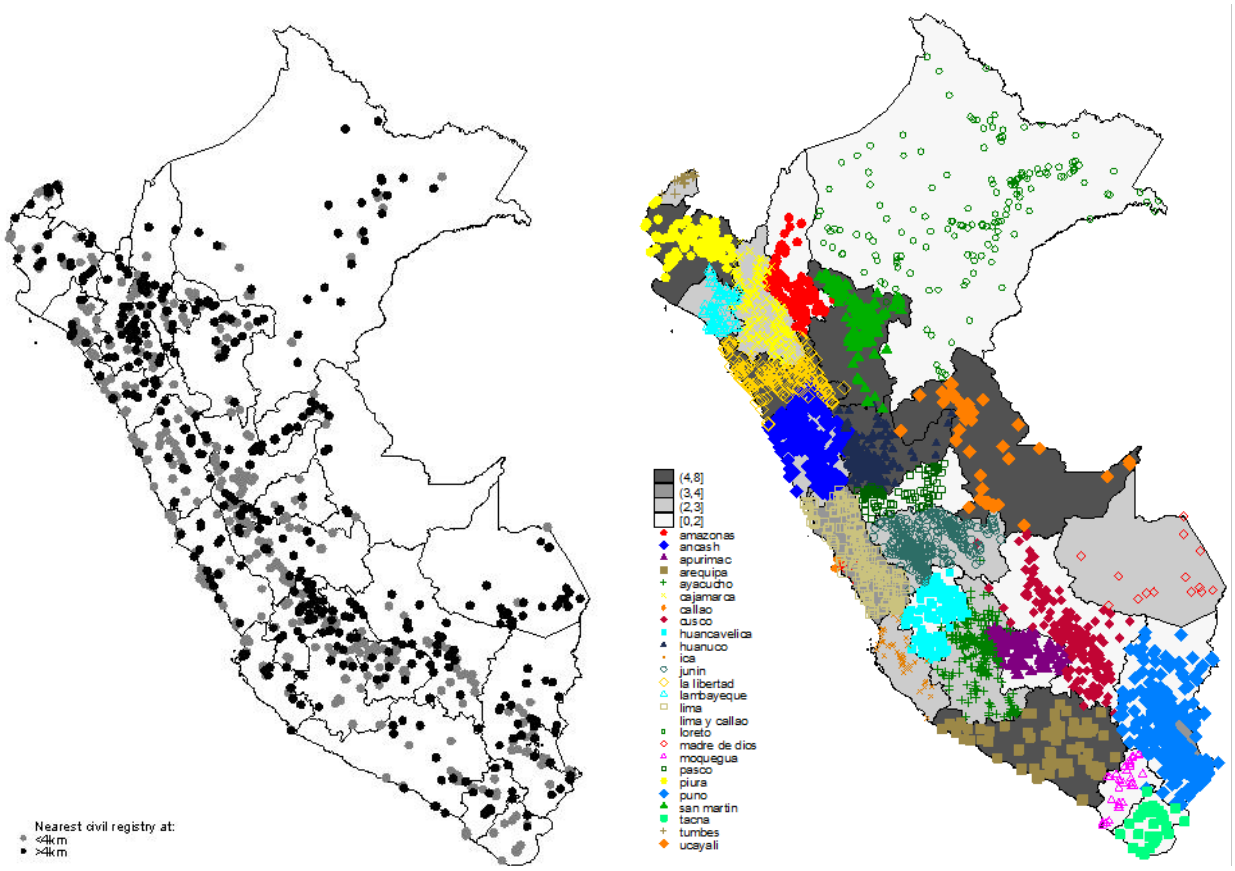
Besides geography, socioeconomic and cultural factors might also be determinants of the decision to register a child. If distance from a cluster to a civil registration office is correlated with poverty, ethnicity or education, among others, then it could be incorrect to conclude, solely on the basis of the geographical analysis above, that being far from a registry office causes low birth registration rates. For instance, Figures 6 and 7 show a graphical analysis of Bolivia's and Peru's birth registration rates, controlling for wealth quintile and ethnicity. There are four categories corresponding to four ethnic groups: Aymaras, other indigenous groups (guaranies and others), Quechuas and Spanish speakers. The figures reveal that the richer the household the

lower the proportion of children not registered. There does not appear to be a substantial difference in under-registration rates among Aymaras, Quechuas and Spanish speakers. The sole exception appears to be the group labeled as "other indigenous groups," who show the largest proportion of children not registered and appear to be underrepresented in the richest quintiles. These graphs, nonetheless, do not control for other determinants of under-registration.

Figure 5. Peru, 2004–2008

Clusters of Households | *Civil Registries*

Estimated Probabilities (Y=NO birth certificate)

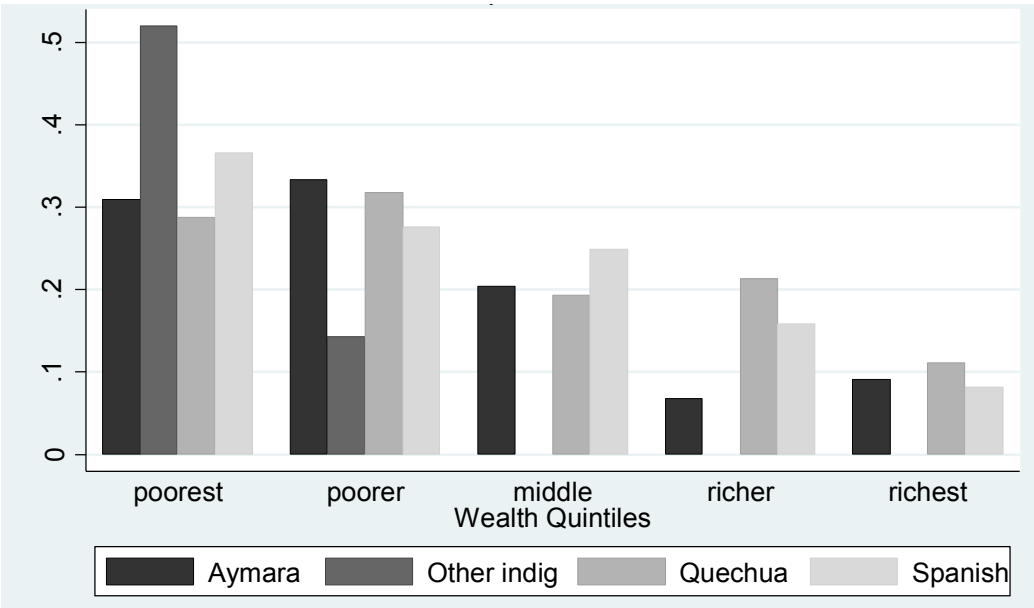


Source: DHS 2004–2008. *Source: NGA, Google Maps and SNRC.*

To account for other variables that might simultaneously determine the decision of registration, we used a multivariate analysis. Tables 6 through 8 present the results of the regressions, including four different econometric specifications. In these tables, columns 1 and 3

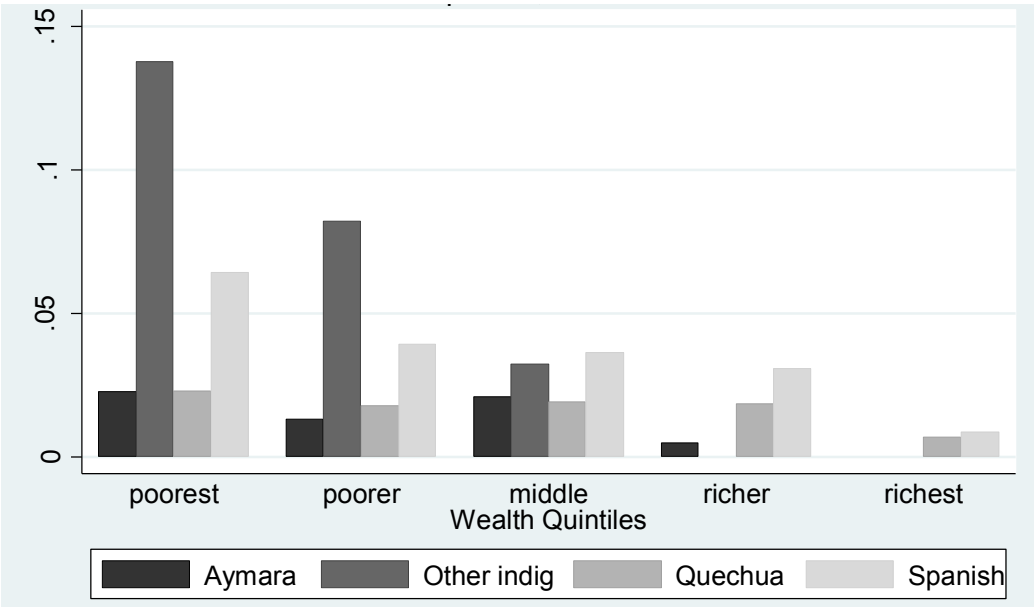
show OLS results; columns 2 and 4 use probit specifications and report the marginal effects evaluated at the mean of the variables.

Figure 6. Bolivia: Under-registration of Births vs. Wealth and Ethnicity, 2008



Source: DHS 2008.

Figure 7. Peru: Under-registration of Births vs. Wealth and Ethnicity, 2004–2008



Source: DHS 2004–2008.

Table 6. Bolivia: Marginal Effects, 2008

Dependent variable is 1 if child does NOT have birth certificate, 0 otherwise

	(1) OLS		(2) PROBIT		(3) OLS		(4) PROBIT	
Distance to nearest registry (1 unit=25 km)	0.038***	(0.012)	0.032***	(0.011)	0.041**	(0.020)	0.035*	(0.019)
Computerized office	0.086	(0.057)	0.107	(0.083)	0.066	(0.088)	0.062	(0.134)
Parents Characteristics								
Parents speak Quechua	-0.002	(0.021)	-0.001	(0.021)	-0.014	(0.021)	-0.013	(0.020)
Parents speak Aymara	0.011	(0.025)	0.020	(0.027)	-0.006	(0.029)	0.003	(0.030)
Parents speak other natural language	0.082	(0.054)	0.065	(0.052)	0.058	(0.059)	0.039	(0.053)
Teenager mother	0.034**	(0.014)	0.034**	(0.015)	0.033**	(0.015)	0.034**	(0.015)
Mother makes financial decisions	-0.012	(0.017)	-0.012	(0.019)	-0.011	(0.017)	-0.009	(0.019)
Mother lives with partner	-0.076***	(0.019)	-0.078***	(0.023)	-0.077***	(0.019)	-0.079***	(0.023)
Mother has primary education	-0.014	(0.028)	-0.020	(0.026)	-0.012	(0.027)	-0.020	(0.026)
Mother has secondary education	-0.081***	(0.031)	-0.082***	(0.026)	-0.080***	(0.030)	-0.082***	(0.026)
Mother has more than secondary education	-0.163***	(0.033)	-0.167***	(0.019)	-0.163***	(0.033)	-0.164***	(0.019)
Child Characteristics								
Child is a girl	0.021**	(0.010)	0.023**	(0.010)	0.024**	(0.010)	0.027***	(0.010)
Current age of child	-0.109***	(0.004)	-0.118***	(0.005)	-0.109***	(0.004)	-0.119***	(0.005)
Child born during winter	0.057***	(0.010)	0.063***	(0.011)	0.057***	(0.010)	0.064***	(0.011)
First born	0.004	(0.012)	0.004	(0.013)	0.007	(0.012)	0.005	(0.013)
Youngest child	-0.035***	(0.011)	-0.061***	(0.015)	-0.032***	(0.012)	-0.059***	(0.015)
Birth not attended by health spec	0.040***	(0.016)	0.042***	(0.016)	0.034**	(0.015)	0.035**	(0.016)
Household Characteristics								
Wealth	-0.066***	(0.016)	-0.107***	(0.018)	-0.068***	(0.017)	-0.108***	(0.018)
Household has a car	-0.011	(0.015)	-0.013	(0.019)	-0.005	(0.015)	-0.008	(0.019)
Altitude in km	-0.010	(0.010)	-0.012	(0.010)	0.018	(0.017)	0.018	(0.017)
Household head is male	0.009	(0.018)	0.001	(0.019)	0.012	(0.018)	0.007	(0.019)
Households head age	-0.001**	(0.001)	-0.001**	(0.001)	-0.001**	(0.001)	-0.001**	(0.001)
Health center far away	0.059	(0.037)	0.049	(0.038)	0.052	(0.038)	0.041	(0.038)
Without utilities (water/elect)	0.015	(0.026)	0.013	(0.025)	0.030	(0.027)	0.028	(0.027)
Number of people in the cluster	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Rural	0.035**	(0.016)	0.032**	(0.016)	0.032*	(0.019)	0.028*	(0.015)
Constant	0.489***	(0.065)			1.096***	(0.084)		
Observations	6438		6438		6438		6433	
R-Squared	0.186				0.210			
Department fixed effects	Yes		Yes		No		No	
Province fixed effects	No		No		Yes		Yes	

Standard errors in parentheses.
** p < 0.1, ** p < 0.05, *** p < 0.01.*
Marginal effects for discrete change of dummy variable from 0 to 1.
The sample has been restricted to those who live at less than 80km from any civil registry and to those households who lived in the same house before the child was born (93 percent).

Table 7. Dominican Republic: Marginal Effects, 2007

Dependent variable is 1 has NOT birth certificate, 0 otherwise

	(1) OLS	(2) PROBIT	(3) OLS	(4) PROBIT
Distance to nearest registry (1 unit=25 km)	0.185*** (0.049)	0.164*** (0.041)	0.126** (0.056)	0.118** (0.052)
Parents Characteristics				
Mother without national ID (*cédula de identidad*)	0.372*** (0.026)	0.298*** (0.029)	0.370*** (0.027)	0.319*** (0.031)
One parent born abroad	0.255*** (0.030)	0.213*** (0.033)	0.262*** (0.030)	0.229*** (0.036)
Teenager mother	0.127*** (0.023)	0.117*** (0.024)	0.125*** (0.023)	0.119*** (0.025)
Mother makes financial decisions	0.009 (0.018)	0.006 (0.017)	0.012 (0.018)	0.008 (0.018)
Mother has primary education	-0.102***(0.027)	-0.059***(0.018)	-0.093***(0.028)	-0.059***(0.019)
Mother has secondary education	-0.193***(0.028)	-0.128***(0.017)	-0.182***(0.029)	-0.131***(0.017)
Mother has more than secondary education	-0.208***(0.029)	-0.146***(0.012)	-0.190***(0.030)	-0.143***(0.013)
Child Characteristics				
Child is a girl	-0.010 (0.009)	-0.012 (0.009)	-0.009 (0.009)	-0.012 (0.009)
Current age of child	-0.043***(0.003)	-0.045***(0.004)	-0.041***(0.003)	-0.044***(0.004)
Child born during winter	-0.005 (0.009)	-0.005 (0.009)	-0.001 (0.009)	-0.003 (0.009)
First born	-0.043** (0.017)	-0.046***(0.016)	-0.033* (0.017)	-0.037** (0.016)
Youngest child	-0.064***(0.015)	-0.069***(0.015)	-0.056***(0.015)	-0.061***(0.015)
Birth not attended by health spec	0.080** (0.036)	0.056* (0.034)	0.063* (0.037)	0.040 (0.034)
Household Characteristics				
Wealth	-0.059***(0.005)	-0.074***(0.007)	-0.059***(0.005)	-0.074***(0.007)
Household has a car	0.013 (0.014)	0.004 (0.023)	0.011 (0.014)	0.001 (0.024)
Altitude in km	0.043 (0.046)	0.015 (0.036)	0.073 (0.064)	0.032 (0.055)
Household head is male	-0.003 (0.013)	-0.003 (0.015)	0.002 (0.014)	0.003 (0.015)
Household head age	0.000 (0.000)	0.001 (0.000)	0.001 (0.000)	0.001 (0.000)
Rural	-0.010 (0.015)	-0.012 (0.014)	-0.008 (0.016)	-0.002 (0.016)
Health center far away			0.008 (0.013)	0.008 (0.012)
Without utilities (water/elect)			0.041 (0.036)	0.009 (0.028)
Number of people in the cluster			-0.000 (0.000)	-0.000 (0.000)
Constant	0.505*** (0.063)		0.415*** (0.086)	
Observations	6217	6217	6202	6202
R-squared	0.221		0.266	
Province fixed effects	Yes	Yes	No	No
Municipality fixed effects	No	No	Yes	Yes

*Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01. Marginal effects for discrete change of dummy variable from 0 to 1. The sample has been restricted to households who lived in the same house before the child was born (94 percent).*

Table 8. Peru: Marginal Effects, 2004–2008

Dependent variable is 1 if child does NOT have birth certificate, 0 otherwise

	(1) OLS		(2) PROBIT		(3) OLS		(4) PROBIT	
Distance to nearest registry (1 unit=25 km)	0.020	(0.021)	0.006	(0.006)	0.019	(0.020)	0.006	(0.013)
Parents Characteristics								
Mother without national ID (DNI)	0.084***	(0.017)	0.040***	(0.010)	0.087***	(0.016)	0.066	(0.074)
Parents speak Quechua	-0.001	(0.006)	0.002	(0.005)	0.001	(0.006)	0.005	(0.009)
Parents speak Aymara	-0.012*	(0.007)	-0.013**	(0.006)	-0.020**	(0.009)	-0.020	(0.030)
Parents speak other natural language	-0.012	(0.027)	-0.007	(0.006)	-0.045	(0.033)	-0.017	(0.026)
Teenager mother	0.041	(0.026)	0.014	(0.012)	0.044*	(0.026)	0.024	(0.036)
Single mother	-0.022**	(0.011)	-0.010	(0.006)	-0.022**	(0.011)	-0.016	(0.021)
Mother has primary education	0.005	(0.008)	0.005	(0.006)	0.002	(0.008)	0.004	(0.010)
Mother has secondary education	-0.003	(0.010)	-0.001	(0.006)	-0.008	(0.011)	-0.007	(0.013)
Mother has tertiary education	-0.014	(0.011)	-0.010**	(0.005)	-0.018	(0.011)	-0.017	(0.025)
Child Characteristics								
Child is a girl	0.018**	(0.009)	0.015**	(0.007)	0.020**	(0.009)	0.016**	(0.009)
Current age of child	-0.005***	(0.002)	-0.004***	(0.001)	-0.005***	(0.002)	-0.005	(0.006)
First born	-0.006	(0.011)	-0.003	(0.005)	-0.008	(0.011)	-0.004	(0.009)
Youngest child	-0.015*	(0.008)	-0.012**	(0.006)	-0.017**	(0.008)	-0.017	(0.023)
Birth not attended by health specialist	0.009*	(0.005)	0.006	(0.004)	0.006	(0.006)	0.006	(0.010)
Household Characteristics								
Wealth index	-0.014***	(0.003)	-0.009***	(0.002)	-0.013***	(0.004)	-0.012	(0.017)
Household has a car	0.004	(0.006)	-0.007	(0.006)	-0.000	(0.006)	-0.013	(0.019)
Altitude in km	-0.008***	(0.003)	-0.007***	(0.002)	-0.005	(0.004)	-0.009	(0.013)
Household head age	-0.000	(0.000)	-0.000	(0.000)	-0.000	(0.000)	-0.000	(0.000)
Household head is male	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.019	(0.026)
Year	-0.001	(0.002)	-0.001	(0.001)	-0.002	(0.002)	-0.001***	(0.000)
Rural	-0.018**	(0.007)	-0.012**	(0.005)	-0.025***	(0.007)	-0.021	(0.030)
Health center far away					-0.001	(0.005)	-0.002	(0.005)
Without utilities (water/elect)					0.014	(0.019)	0.005	(0.014)
Number of people in cluster					0.000*	(0.000)	0.000	(0.000)
Constant	2.969	(3.965)			4.737	(4.250)		
Observations	9104		8871		9104		6155	
R-squared	0.056				0.084			
Region fixed effects	Yes		Yes		No		No	
Province fixed effects	No		No		Yes		Yes	

*Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01. Marginal effects for discrete change of dummy variable from 0 to 1. The sample has been restricted to include only those who live in the same house before the child was born (95 percent).*

The results suggest that increasing the distance to the nearest registry office by 25 kilometers is associated with a 4 percentage point increase in the probability of not registering a child's birth in Bolivia, and 12 percentage points in the Dominican Republic. The size of the impact of distance on birth registration compared to the effect of other determinants entails a substantial economic significance. For example, for Bolivia, Table 6 shows that the size of the coefficient of the variable distance is about half the size of that of the variable "Mother has secondary education." In the Dominican Republic (Table 7), reducing distance by 25 kilometers would be equivalent to universalizing secondary education among women. However, in the Dominican Republic, the coefficient that stands out is the one associated with a parent being of foreign origin. This is likely related to undocumented Haitians, as it is mirrored in Figure 4, which maps the regions next to the border with Haiti and shows higher estimated probabilities of not registering a child's birth. Since we feared that immigrants without documents would be afraid of approaching government offices, we ran a regression for the Dominican Republic excluding children of parents born abroad. Basically, our results about distance being statistically significant did not change.[15]

For Peru, the results are less robust. Table 8 shows that distance is not significantly associated with under-registration rates. This could be due to two potential problems. First, there could be a measurement error related to both the demand and supply side of birth registration. There are 447 clusters of households and 683 civil registries whose GPS data are missing. This causes a drop in the usable number of observations of about 30 percent, which could bias the results. Despite these potential econometric problems, it is worth noting that the coefficient is positive, suggesting that lack of registration services in some areas of Peru could also be a cause of under-registration of births.

In the Dominican Republic and Peru, birth under-registration is linked to the lack of documents of identification of the mother. The mother not having a national identity card increases the probability of under-registration by 33 percentage points in the Dominican Republic and 8 percentage points in Peru. This is empirical evidence that lack of documents of identification is self-perpetuating. This is another pervasive form of inter-generational

[15] These results are available on request.

transmission of poverty and exclusion that has not been discussed in the economics literature before and deserves critical attention.

With respect to ethnicity, we find no significant effect in Bolivia or Peru. This suggests that, in general, ethnicity is not associated with under-registration. It seems that other socioeconomic determinants, such as poverty and lack of education, which are typically prevalent among indigenous groups, are driving the results.

The other variables that are interesting to note are whether or not the child in question was the first born or the youngest. In all three countries, the coefficient associated with the youngest was negative and significant, indicating that parents might experience a learning curve. A first born child's always lower probability of being registered may be attributed to parents' need to learn about how the whole process of registration is done.

Finally, both a mother's level of education and household wealth impact the chances of under-registration. More educated mothers perceive higher benefits for their children or perhaps can find information about the process more easily. The greater prevalence of under-registration among poor households indicates that economic costs are important factors that impede registration of the children.

In regards to the effect of distance on the proportion of children without a birth certificate, an increase of 25 kilometers in the distance from the nearest civil registry office raises the proportion of children without a birth certificate by 8 percentage points in Bolivia and by 17 percentage points in the Dominican Republic (Tables 9 and 10). The same increase in distance raises the probability of finding a household where all children lack a birth certificate by 4 percentage points in Bolivia and by 8 percentage points in the Dominican Republic. These results provide additional evidence in favor of the hypothesis that distance is a determinant of the registration of children's births. In contrast, for Peru, distance did not affect either the proportion per household of children without a birth certificate or the probability that all children per household lack a birth certificate (Table 11).

Table 9. Bolivia: Robustness Check, 2008

	(1)	(2)	(3)	(4)
	Proportion of children in the household without birth certificates		1 if all children do NOT have birth certificates, 0 otherwise	
Dependent variables	OLS	GLM	OLS	PROBIT
Distance to nearest registry (1 unit=25 km)	0.056**	0.075***	0.048**	0.040**
	(0.023)	(0.019)	(0.023)	(0.019)
Observations	4902	4933	5170	5102
R2	0.108		0.084	

*Marginal effects. Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01. Regression includes controls for computerization of offices, parents' characteristics, children's characteristics, household characteristics and fixed effects per province. The GLM model provides robust estimates with fractional response variables as in Papke and Wooldridge (1996).*

Table 10. Dominican Republic: Robustness Check, 2007

	(1)	(2)	(3)	(4)
	Proportion of children in the household without birth certificates		1 if all children do NOT have birth certificates, 0 otherwise	
Dependent variables	OLS	GLM	OLS	PROBIT
Distance to nearest registry (1 unit=25 km)	0.128**	0.172***	0.094*	0.079**
	(0.055)	(0.030)	(0.050)	(0.038)
Observations	4851	4851	5426	5179
R2	0.220		0.182	

*Marginal effects. Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01. Regression includes controls for parents' characteristics, children's characteristics, household characteristics and fixed effects per municipality. The GLM provides robust estimates with fractional response variables as in Papke and Wooldridge (1996).*

Table 11. Peru: Robustness Check, 2004–2008

	(1)	(2)	(3)	(4)
	Proportion of children in the household without birth certificates		1 if all children do NOT have birth certificates, 0 otherwise	
Dependent variables	OLS	GLM	OLS	PROBIT
Distance to nearest registry (1 unit=25 km)	0.027	0.000	0.015	0.006
	(0.020)	(0.000)	(0.016)	(0.054)
Observations	3178	4331	3198	1031
R2	0.150		0.062	

*Marginal effects. Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01. Regression includes controls for parents' characteristics, children's characteristics, household characteristics and fixed effects per province. The GLM model provides robust estimates with fractional response variables as in Papke and Wooldridge (1996).*

Policy Implications

The first and most straightforward policy implication of our results is that there is significant scope to reduce birth under-registration by improving the equitability of access to registration services. This could be achieved by creating new offices; however, where that is not cost-effective due to low population density, mobile campaigns could be used periodically to ensure that births are registered. An evaluation of such campaigns is needed to assess their effectiveness. Governments that have little resources could also explore the efficacy of redistributing existing offices.

Second, efforts to reduce the distance to registration offices can be a powerful complement to other public policy interventions. The economic significance of distance as a barrier to registration is as large as or larger than other barriers related to access to health and education. Increasing maternal education levels or improving standard of living may take years to achieve, but policies to increase access to registration facilities may be easier to implement and provide more immediate results.

Third, campaigns to increase awareness of the adverse consequences of under-registration may be worthwhile. Governments could distribute booklets with specific information—such as information about the registration process and real life stories of people who faced the consequences of lack of documents of identification—in hospitals and health centers. In addition, governments might periodically disseminate messages about the importance of registration using radio or television to reach more remote areas. In Bolivia, targeted campaigns during the rainy season may be particularly important. It is not rare in developing countries, particularly those in the tropics, to find some roads functional only during the dry season. Our results show that the probability of children born during the rainy season in Bolivia not obtaining a birth certificate is significantly higher than those born in the dry season.

Fourth, in countries with strong immigration flows, a nation-to-nation dialogue is needed to regulate the registration of children born of illegal immigrants. The lack of dialogue between two nations may reflect political and cultural differences; however, without mutual understanding, a significant number of children will be condemned to a life of exclusion.

Fifth, lack of documents of identification is a self-perpetuating problem. Mothers without a document of identification have less chance of registering their children's births than do mothers with identification. Efforts to ensure mothers have documents of identification could begin during prenatal care at health centers.

Finally, all household surveys and censuses should incorporate questions regarding legal documents of identifications and collect GPS data for households and public services. Currently, there is a significant information gap with regard to registration of people and other data routinely collected to assess standards of living in household surveys. Most of these surveys in the developing world contain rich information about consumption, income, health, education and assets, etcetera. But relatively few surveys include questions about documents of legal identification, severely limiting analysis of this initial form of social exclusion. In addition, there are no surveys related to the infrastructure and the human capital involved in providing public services.

Conclusions

Birth registration guarantees a child's fundamental right to an identity. It reduces the risk of lifelong exclusion since access to social benefits, formal labor markets and other key public institutions hinge on legal proof of identity. Lack of registration also undermines the state's capacity to design public policies and manage public resources, given that essential information provided by civil registries is incomplete. While birth registration rates in the LAC region are on average better than in other parts of the world, some countries are still far from achieving universal registration.

In qualitative studies, distance to birth registration facilities often appears as an important barrier. To our knowledge, this is the first paper to empirically quantify the impact of distance on the probability of birth registration. After controlling for many other potential determinants of under-registration, we found that distance matters. The disincentive provided by distance is as strong as or stronger than other indicators of socioeconomic background that have been deemed important in previous literature.

We found wide disparities in the equitability of access to civil registries between and within the three countries studied. This imbalance is due to both the lack of civil registry offices in some areas and by a sub-optimal distribution of offices. This is particularly true for Bolivia, which exhibits the highest rate of under-registration of children aged 0 to 4. In the Bolivian departments of Beni, Cochabamba and Santa Cruz, the civil registries seem to be clustered around large cities, leaving vast parts of their territories unattended. Perhaps it is for this reason that these departments exhibit the largest number of households that are positioned at more than 25 kilometers from a civil registry and have the highest proportion of people unregistered. Peru, in contrast, has the most even distribution of civil registries despite being a large country of over 1.2 million square kilometers with a population of 28 million.

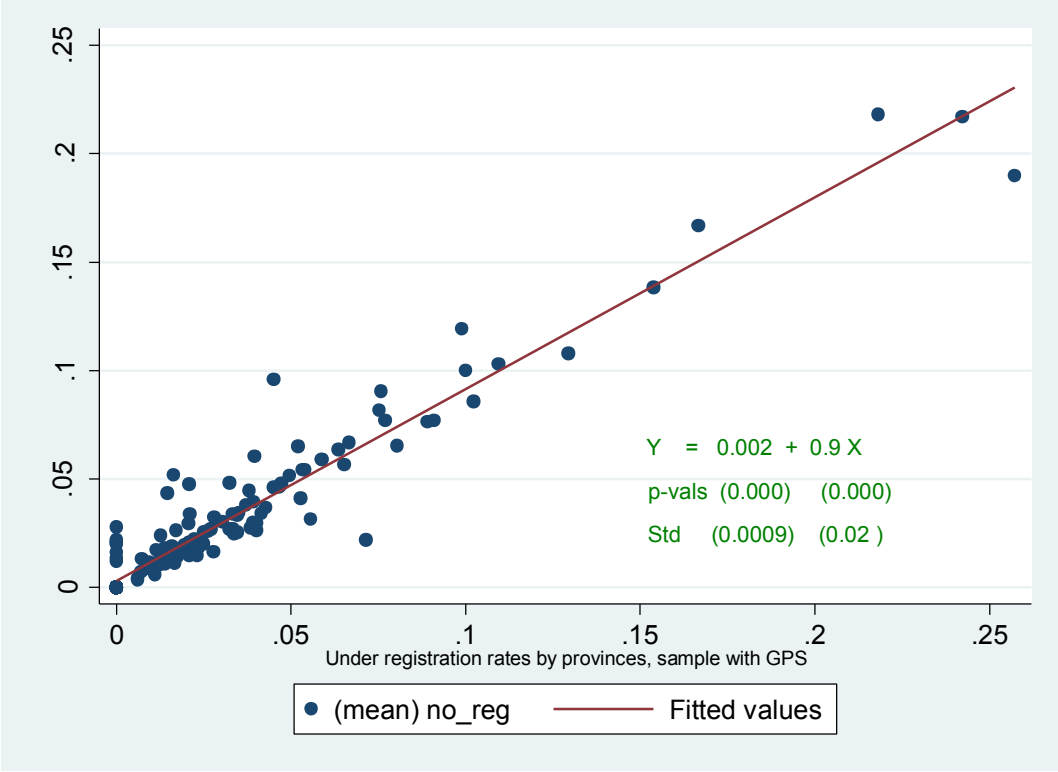
Our findings provide an important input for policy design. Shortening the distance of households to civil registration offices could significantly improve rates of birth registration. Policies to improve access to registration facilities would thus be a powerful complement to other public interventions that can help reduce the incidence of under-registration, such as improving the access to health facilities for birth deliveries and increasing maternal education levels.

It is worth evaluating the impact of policies related to distance given their potential to have more immediate effects at lower costs. Despite mobile campaigns to reach those living in remote areas, Bolivia and the Dominican Republic still have low birth registration rates. Without a rigorous evaluation of the effectiveness of these campaigns, it is difficult to discern if it is cost-effective to continue them, to install permanent registry offices or to do both. Further work is also needed to assess the potential benefits of redistributing existing offices. In addition, the general population, especially women living in remote areas, must be educated about the process and benefits of registration.

Given their low costs, GPS devices should be used in every household survey and census. To offer a comprehensive assessment of a country's public services, inventories of public infrastructure should be collected. In this way, demand and supply side factors could be taken into account simultaneously to analyze outcomes of interest. Finally, all household surveys and censuses should incorporate questions regarding legal documents of identification to better understand the problem of birth under-registration and improve the design of public policies.

Appendix 1. Peru 2004–2008:

Does the Missing GPS Data Cause Sample Bias in Peru?



Source: Authors' elaboration based on DHS 2004–2008.

Appendix 2. Variation in Survey Questions on Birth Certificates and Other Variables Used

Bolivia

- Does NAME have an official birth certificate?

  1 if child does NOT have birth certificate; 0 otherwise.
- Do the parents speak Quechua, Aymara or another natural language?

  1 if parents speak Quechua, Aymara or another natural language; 0 otherwise.
  - Which language did NAME learn during childhood?

    Possible answers: Quechua, Aymara, Guarani, Castellano, other, foreign language, cannot speak or cannot speak yet.
- Are you currently married or living with a man? (Mother with partner)

  1 if mother has a partner; 0 otherwise.
- Who decides how the money that your husband earns is spent?

  Possible answers: you, mainly your partner or joint decision.
  - Does the mother decide on money?

    1 if mother alone decides on money; 0 otherwise.
- Was the birth attended by a health specialist?

  1 if birth was not attended by a doctor, nurse or auxiliary personnel; 0 otherwise.
  - Who attended the birth of NAME?

    Possible answers: doctor, nurse, auxiliary personnel, midwife, partner, friends, other or nobody.
- Was the child born during the rainy season?

  1 if child was born from November to March; 0 otherwise.
- Is the civil registry office computerized?

  1 if civil registry is computerized; 0 otherwise.

Dominican Republic

- Does NAME have an official birth certificate? Was it declared?

  1 if child does NOT have birth certificate; 0 otherwise.
- Were either of the parents born abroad?

  1 if at least one parent was born abroad; 0 otherwise.

- Where was NAME born?

  Possible answers: where interview took place, other location within this country, abroad or do not know.

- Was the birth attended by a health specialist?

  1 if mother did NOT give birth at medical facility; 0 otherwise.

  - Who attended the birth of NAME?

    Possible answers: general doctor, gynecologist, obstetrician, doctor in another specialty, nurse, midwife, partner, friends, other or nobody.

- Does the mother decide on money?

  1 if mother alone decides on money; 0 otherwise.

  - Who primarily decides on how the money that your husband earns is spent?

    Possible answers: you, both, your partner, husband does not contribute or other.

- Was the child born during the winter?

  1 if child born from May to November; 0 otherwise.

Peru

- Does NAME have an official birth certificate?

  1 if child does NOT have birth certificate; 0 otherwise.

  Possible answers: yes, no but he/she is registered, no or do not know.

- Do the parents speak Quechua, Aymara or another natural language?

  1 if parents speak Quechua, Aymara or another natural language; 0 otherwise.

  Possible answers: Quechua, Aymara, Spanish, foreign language or other.

- Does the mother decide on money?

  1 if mother alone decides on money; 0 otherwise.

  - Who primarily decides on how the money that you earn is spent?

    Possible answers: you, both, your partner, someone else, interview with someone else.

- Was the birth attended by a health specialist?

  1 if mother did NOT give birth at medical facility; 0 otherwise.

  - Where did you give birth to NAME?

    Possible answers: hospital, health center, private health clinic or other.

Appendix 3. Documents Required to Request a Birth Certificate

Bolivia	Dominican Republic	Peru
– The *de facto* custodian of the child needs to present at least one of the following documents: a national identification card (*cédula de identidad*), a valid passport, a *RUN (registro único de identidad)* or a military service card. – If the person requesting the birth certificate does not possess any of the above, two witnesses with proper identification may be brought to testify to the relationship of the person requesting the birth certificate to the child.	– The mother of the child must present her national identity card (*cédula de Identidad*) and the medical certificate that the child was born alive. In the case of a consensual relationship, the father must also present his *cédula de Identidad*. – For married couples, the additional document must be the certificate of marriage. In all cases, the request must be made within the same jurisdiction as the child's birth. Unlike Bolivia and Peru, no witnesses can substitute for the parents or medical certificate of birth.	– The medical certificate stating that the child was born alive or a declaration of a political authority, religious or judicial representative confirming the birth may be brought instead of the medical certificate. – A mandatory document is also the national identity card (*Documento Nacional de Identidad*, DNI) of those requesting the birth certificate, including those brought to substitute for the medical certificate.

Source: Civil registries of each country.

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