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Aftershocks of Chile's Earthquake for an Ongoing, Large-Scale Experimental Evaluation

Lorenzo Moreno[1,2], Ernesto Treviño[3], Hirokazu Yoshikawa[4], Susana Mendive[4,5], Joaquín Reyes[6], Felipe Godoy[6], Francisca Del Río[6], Catherine Snow[4], Diana Leyva[4], Clara Barata[4], MaryCatherine Arbour[7,8], and Andrea Rolla[9]

[1] Mathematica Policy Research, Princeton, NJ, USA
[2] Woodrow Wilson School of Public and International Affairs, Princeton University, Princeton, NJ, USA
[3] Centro de Políticas Comparadas de Educación, Universidad Diego Portales, Santiago, Chile
[4] Harvard Graduate School of Education, Cambridge, MA, USA
[5] School of Education, Pontificia Universidad Catœlica de Chile, Santiago, Chile
[6] School of Education, Universidad Diego Portales, Santiago, Chile
[7] Division of Global Health Equity, Brigham and Women's Hospital, Boston, MA, USA
[8] Center on the Developing Child, Harvard University, Cambridge, MA, USA
[9] Center of Studies, Ministry of Education, Santiago, Chile

Corresponding Author:
Lorenzo Moreno, Mathematica Policy Research, Princeton, NJ, USA and Woodrow Wilson School of Public and International Affairs, Princeton University, Princeton, NJ, USA
Email: lmoreno@mathematica-mpr.com

Abstract

Evaluation designs for social programs are developed assuming minimal or no disruption from external shocks, such as natural disasters. This is because extremely rare shocks may not make it worthwhile to account for them in the design. Among extreme shocks is the 2010 Chile earthquake. *Un Buen Comienzo* (UBC), an ongoing early childhood program in Chile, was directly affected by the earthquake. This article discusses (a) the factors the UBC team considered for deciding whether to put on hold or continue implementation and data collection for this experimental study; and (b) how the team reached consensus on those decisions. A lesson learned is that the use of an experimental design for UBC insured that the evaluation's internal validity was not compromised by the earthquake's consequences, although cohort comparisons were compromised. Other lessons can be transferred to other contexts where external shocks affect an ongoing experimental or quasi-experimental impact evaluation.

Keywords

impact evaluation, human development, external shocks, institutional factors, Latin America and the Caribbean

Introduction

Rigorous evaluation designs for social programs are typically developed assuming minimal or no disruption from external shocks, such as natural disasters (Chile's earthquake, hurricane Katrina, draughts, and others), or social or political upheaval (protests for economic austerity measures, armed conflict, or lack of access to basic services).

Understandably, intervention implementers focus on a broad range of logistical aspects, such as negotiating cooperation from all involved parties in the study, ensuring fidelity of implementation, and minimizing burden to those who agreed to participate in it. Although implementers are attuned to the consequences of delays resulting from administrative, logistical, or political decisions, they do not necessarily, if ever, develop plans for extreme external shocks, mainly because it is difficult to do so.

Likewise, evaluation designers focus on the technical aspects of the design, such as the level of randomization, the statistical power for detecting impacts, the data needed for addressing specific research questions, among others. However, evaluation designs address external shocks that could arise during their implementation and that could compromise their

integrity only if there is high probability that such shocks happen; extremely rare external factors may not make it worthwhile to account for them. When natural disasters occur, both the design of rigorous social experiments may be compromised and their external validity can be questioned.

Among extreme natural shocks is the recent earthquake in Chile. Because this shock is an extremely rare event, it is highly relevant to assess what are the implications of this shock on the impact evaluation of *Un Buen Comienzo* (UBC), an ongoing early childhood program in Chile (Un Buen Comienzo 2010). This article narrates how an experienced evaluation team dealt with two issues when assessing the implications of Chile's earthquake in February 2010 on an ongoing, large experimental evaluation of UBC. Specifically, this article discusses (a) the factors the implementation and evaluation teams considered for deciding whether to put on hold or continue implementation and data collection for a large and rigorous experimental study; and (b) how the teams reached consensus on those decisions. Although there is some literature on the design and implementation of impact evaluations following disasters, there is minimal discussion on the implications of natural disasters for ongoing impact evaluations (Buttenheim 2009).

The article does not pretend that the UBC's problem-solving process is transferable to other settings. Instead, the authors think it may be useful for practitioners to know what to do in the aftermath of an external shock of Chile's earthquake magnitude, and to develop contingency plans for the implementation of their own impact evaluation designs, particularly in international settings where some type of external shock (natural or man-made) is not uncommon.

The Intervention, the Evaluation, and Their Implementation

UBC is an early childhood intervention aimed at fostering teacher capacities for supporting language and socioemotional development, as well as improving health among impoverished children attending public (municipal) schools in the urban area of Santiago, Chile.

UBC is a shared endeavor supported by the participation of several organizations. Fundaciœn Educacional Oportunidad is the main sponsor of UBC. Harvard Graduate School of Education is leading the project by crafting the intervention and its evaluation design. Mathematica Policy Research has advised on the evaluation design and decision making in the field. Finally, Universidad Diego Portales has contributed to the evaluation design and it is implementing the external evaluation of UBC.

The UBC evaluation is a cluster-randomized experimental design that uses multiple methods and sources of data in its design. Preschools within *comunas* (municipalities) are the unit of randomization. The evaluation uses a staggered design consisting of three cohorts (Table 1). For each cohort, municipalities are selected to participate in UBC if they are located in the urban area of Santiago, and if at least 30% of their students are at or below the poverty level. After municipalities are selected, all schools within each municipality are considered eligible for the study. In a few instances, schools have declined their participation in the study after discussing it with the municipalities' authorities.

Schools are randomized through a public lottery. The reason for selecting preschools as the unit of randomization, instead of classrooms or individuals, is that the main aspects of the theory of change behind the UBC intervention occur at the preschool level, not at the classroom or student levels. The question that UBC and its evaluation strive to answer is how preschool education can be improved, not whether preschool is better than no preschool. Therefore, the counterfactual condition is by necessity a population already involved in a preschool system, not a population that is not receiving any preschool education. In order to address this question, the UBC evaluation compares two conditions: Intervention 1 represents the full UBC program of teacher professional development, while intervention 2 consists of a one-day workshop on self-care and a package of five books. Intervention 2 schools receive a different and limited treatment in comparison to intervention 1 schools. The randomization of preschools should yield unbiased comparisons between the two conditions.

UBC offers services during 2 years to the whole preschool, that in Chile includes prekinder and kindergarten. The evaluation is designed to follow for 2 years students entering prekinder at the beginning of each cohort. Students are assessed at three points on time. For each cohort, the evaluation assesses children, parents, and teachers when children start prekindergarten (baseline in March–May), at the end of prekindergarten (October–November of the year of enrollment), and at the end of kindergarten (October–November of the following year of enrollment in prekindergarten). In 2008, one municipality with six schools became the first cohort of the study. In 2009, two municipalities entered into the evaluation with a total of 29 schools (cohort 2). Finally, in 2010, three municipalities started the evaluation with 29 schools (cohort 3). As of December 2010, the evaluation had finished collecting data for the six schools of cohort 1. Also, the 29 schools from cohort 2 have completed their third, and final, round of data collection. Finally, the 29 schools from cohort 3 have completed their second round of data collection.

Table 1. UBC Evaluation Design by Cohort, Time of Data Collection, and Year

		2008		2009		2010		2011	
Cohort	Schools	(March–May)	(October–November)	(March–May)	(October–November)	(March–May)	(October–November)	(March–May)	(October–November)
1	Intervention 1 ($n = 3$)	Baseline t1 starting pre-k	t2 end pre-k		t3 end of k				
	Intervention 2 ($n = 3$)	Baseline t1 starting pre-k	t2 end pre-k		t3 end of k				
2	Intervention 1 ($n = 15$)			Baseline t1 starting pre-k	t2 end pre-k		t3 end of k		
	Intervention 2 ($n = 14$)			Baseline t1 starting pre-k	t2 end pre-k		t3 end of k		
3	Intervention 1 ($n = 14$)					Baseline t1 starting pre-k	t2 end pre-k		t3 end of k
	Intervention 2 ($n = 15$)					Baseline t1 starting pre-k	t2 end pre-k		t3 end of k

Note: 2,314 children participate in the evaluation.

The analysis of UBC impact will pool the data of the three cohorts in the sample to estimate the impact of this intervention on language, socioemotional development, and health with high confidence.

The Earthquake and Its Aftermath

On February 27, 2010, at 3:27 a.m., Chile suffered the fifth strongest earthquake since these phenomena have been measured (United States Geological Service 2010). Although its main effects were felt in the southern regions of El Maule and Bío Bío, the earthquake created physical and psychological damage in Santiago.

Data collection from schools in cohort 3 was planned to start the third week of March. However, the earthquake caused a 1-week delay in the start date of the school year in Santiago, which typically starts the first week of March. It also interrupted some basic services in several areas of the city and damaged infrastructure and dwellings.

From the standpoint of the UBC evaluation, the earthquake had a direct effect on the evaluation's *external validity* (that is, the generalizability of the findings and the interpretation of the impact estimates), particularly on the ability of the study to compare findings across cohorts, given the staggered implementation of the experimental design. Fortunately, the analyses that the evaluation team has performed showed that the results of the study actually may be generalizable to the municipalities of the metropolitan area of Santiago that were eligible to participate in the study. This is because the UBC schools had at least 30% of vulnerable children attending their schools, which corresponds closely to the remainder of eligible non-UBC municipalities in the Santiago metropolitan area. Furthermore, the analysis showed that UBC municipalities were similar to other eligible municipalities regarding the students' socioeconomic status and levels of achievement, according to the results of the national educational evaluation system in Chile for fourth graders in 2009 (SIMCE 2009).

The literature on experimental designs with human subjects has pointed out the challenges to preserve randomization. This research has focused on how noncompliance affects randomization to the point of creating a broken or undermined experiment (Barnard et al. 1998, 2003; Frangakis and Rubin 1999; Imbens and Rubin 1997). Fortunately, in the case of UBC evaluation, the earthquake has not compromised randomization, and the rates of compliance with the condition in which schools, teachers, and children have been assigned is similar to that of previous cohorts, as discussed below.

Relatedly, because of the evaluation's design, its *internal validity* (that is, that impact estimates are not biased) remains unaffected by the earthquake, as this event affected equally the intervention 1 and intervention 2 schools (Duflo, Glennerster, and Kremer 2006).

Finally, although the earthquake also affected the intervention and evaluation in other ways, such as the earthquake's psychological effects on teachers, children, and their families, these events should not bias the impact estimates. Thus, the choice of a cluster-randomized design guarantees that the integrity of the impact evaluation, from the internal's validity perspective, is fully preserved.

The Options

As noted, after the earthquake, cohort 3 was to enter the UBC evaluation in March 2010. However, the disturbances to normal life following the earthquake left challenges that required serious consideration because of the potential effects of this natural disaster on the implementation of the intervention and evaluation for the last cohort of the study, as well as on the remaining round of data collection for cohort 2. Furthermore, because the evaluation design calls for pooling the impact estimates across the three cohorts, consideration of the effects of the earthquake across cohorts was critical for assessing the feasibility of doing this pooling.

The initial assessment of the effects of the earthquake on the UBC study led to two options:

- *To suspend the study in 2010 and reinitiate it in 2011*. This option was based on four hypotheses: (a) that schools may have suffered damages in their infrastructure; (b) that the data collection period could take longer than expected under regular conditions, delaying the start of the intervention in comparison to the previous cohorts; (c) that there were psychological impacts on students and teachers because of the earthquake and its aftershocks; and (d) just as important, that the intervention might need to be changed sufficiently and would not be the same program in 2010 as it was in 2008 or 2009, or would be in 2011. Altogether, if these hypotheses proved true, a large cohort effect was expected because of the sudden change in contextual conditions, greatly complicating the pooling of the data for the analysis.
- *To maintain the evaluation calendar with minor adjustments*. The hypotheses behind this alternative were the following: (a) the effects of the earthquake were only temporary and were not widespread in

Santiago, because the epicenter was located in the south of Chile; (b) the process of data collection was not going to be heavily affected by the earthquake; (c) the cohort effect caused by delaying the study by 1 year could be similar to the impact of the psychological effects of the earthquake on teachers and students; (d) putting on hold the project for 1 year could create scarcity of funds and limitations to maintaining local personnel already trained; and (e) the intervention, although likely to incorporate more self-care components for teachers and coaches, would not be drastically different from the UBC program implemented in prior years. In sum, if these hypotheses proved true, the cohort effect due to the earthquake would be negligible, allowing for the pooling of data for the impact analysis.

Reaching a Decision

The decision-making process first involved the recognition that the earthquake could have an impact on the evaluation's external validity and the compliance of participants in the project. This triggered the second phase of decision making, which consisted of collecting inputs to test the hypotheses for each of the two options for the continuation of the UBC study. This process involved collecting data on school infrastructure damage; establishing communication with municipal authorities regarding their plans for starting the school year; asking education and development economists in Chile for advice on how to deal with the situation; and communicating with the main funder to assess the viability of delaying the project 1 year.

The data-collection process lasted 1 week, in which the teams from the Universidad Diego Portales and the Fundaciœn Educacional Oportunidad worked frantically. The implementation team visited the three municipalities (and their schools). The evaluation team assessed the possibility of speeding up the data-collection process, establishing different deadline scenarios, and discussed these possibilities with the municipalities. The teams also studied the possible effects of both delaying the study 1 year and continuing the evaluation with minor changes. Finally, the intervention and evaluation teams consulted the main funding institution to study the financial impact of the two options described above.

The team decided to continue with the UBC study as planned, with minor adjustments to the schedule of the evaluation, as well as a careful monitoring of the situation to determine if the intervention needed to include a session on the management of stress in a disaster situation. The data analysis showed that only one school from cohort 2—receiving

intervention 1—suffered infrastructure damages. Moreover, the state of anxiety in the schools resulting from the aftershocks seemed to fade over time, despite numerous aftershocks of considerably intensity. In addition, the teams collected data from teachers and parents in cohort 3 to assess the impact that the earthquake may have had in classroom life and household organization, respectively. These data show that only 3.6% of the parents reported to have suffered a structural damage at home as a consequence of the earthquake. In addition, 19.4% of the parents mentioned that their children had problems sleeping after the earthquake, and 23.4% reported that the earthquake affected family income. However, none of these factors showed statistically significant differences when comparing the two interventions assessed in the study. Further analyses will be implemented in order to assess the behavior of cohort 3 when data become available. Then, if it is considered appropriate, these analyses may be considered when interpreting the impact estimates. This may require both checking for cohort effects and controlling for variables that measure the effect of the earthquake in classrooms and families.

It is worth noticing that the interventions did not suffer major changes, mainly because it was possible to return to normal school operation very rapidly. Only the one school mentioned above from cohort 2 shared classroom space with another school of the intervention 1 group for one semester.

Finally, it is important to analyze if the external shock had an impact on compliance among participants (Barnard et al. 1998, 2003; Frangakis and Rubin 1999; Imbens and Rubin 1997). The comparison of the rates of compliance for cohort 3 with the previous two cohorts suggests that the earthquake did not undermine or break the experimental design. In fact, children in cohort 3—the one affected by the earthquake when entering the study—showed significantly higher levels of compliance (91%) after a full year of participation in the study in comparison to children in cohort 2 (80%).

Discussion and Lessons Learned

The UBC implementation and evaluation teams rapidly reacted to the broad range of consequences of the February 27th Chile earthquake. The timing of this response was critical because schools were scheduled to open for classes about 1 week later, with baseline data collection for the new cohort of schools following at its heels. Probably one of the most important factors that contributed to this rapid response was the close communication among

the teams, as well as with the funder, school principals, municipality leaders, and education authorities. This impressive demonstration of leadership happened even when earthquake replications continued in Santiago, further disrupting any sense of normalcy after the earthquake. Early communication with key decision makers to identify and mitigate potential barriers to implementing a high-quality impact evaluation is one of the best practices suggested by a recent study on closing the *evaluation gap* in international settings (Moreno et al. 2009).

From a methodological perspective, the use of a cluster-randomized evaluation design proved to be a wise decision because, among other methodological advantages, the evaluation's internal validity was fully preserved, as the earthquake affected equally the intervention 1 and 2 groups. However, had the external shock affected the treatment and control groups differently there is need to understand how much of the causal inference in the evaluation design may be affected, and how to proceed to establish the extent to which causality determination could have been compromised.

From an implementation perspective, many of the decisions regarding the required adjustments in response to external shocks are specific to the circumstances of Chile, and most likely nontransferable to other settings. However, there are others that could conceivably become the basis for developing contingency plans for the implementation of high-quality impact evaluations, particularly in international settings where some type of external shock (natural or man-made) is not uncommon. Building consensus among international practitioners and methodologists about what these contingency plans should include and how to implement them remains an important challenge for the evaluation field.

The experience of the earthquake in Chile and its effects on the UBC evaluation provide the following lessons that can be transferred to other contexts where external shocks affect an ongoing impact evaluation with either experimental or quasi-experimental designs:

First, it is necessary to assess the severity of the event for the target population—specifically, whether the target population can absorb the intervention at all, given more pressing concerns of health and life. If the event is severe enough, survival needs must take priority over all the more secondary needs served by the intervention. If, on the other hand, the intervention itself incorporates attention to survival needs, it may be in a particularly good position to respond to the disaster or emergency.

Second, staff serving in the intervention and evaluation may also be affected by the external shock, and it is necessary to assess if they can continue with their duties after being confronted with the disaster. Their dual

status as survivors of the event as well as service providers or researchers working with survivors among the target population must be considered in designing supports for this population. In our data, although parents reported higher levels of psychological distress following the earthquake than teachers, the teachers reported elevated levels of distress as well, which UBC implementation staff successfully dealt with.

Third, communication among actors involved may be disrupted, leading to challenges for coordinating the intervention and the evaluation. The time frame of intervention implementation and evaluation, resting as it does on technologies as the Internet that may be drastically altered by an external shock, leading to failures in coordination before the communication systems return to normal.

Fourth, the effect of the external shock must be measured in relation to the design of the evaluation and proportion of the sample affected in the context of a longitudinal research design. For example, if multiple cohorts sampled in different geographic areas are included in an evaluation study, some are likely to be disproportionately affected by the event. In our case, over half of the study sample was affected by the earthquake during the course of the evaluation, because the last cohort represents nearly that proportion of the sample. However, the geographic effect was minimal given that the intervention is located in the greater Santiago area where physical damage was narrowly localized.

Fifth, it is necessary to delineate the extent to which the intervention might need to change to accommodate new needs created by the event. Adaptation of the intervention may be necessary, by, for example, including crisis intervention, some attention to survival needs such as food, shelter, water, and health care, and/or mental health counseling and intervention. If such adaptations are substantial enough, it may be necessary to suspend evaluation activities for a time, in that the intervention and its potential proximal and distal effects have changed dramatically. In our judgment, in the case of UBC, it was decided not to change the intervention since the conditions described above were not met.

Sixth, if the program and its evaluation need to be interrupted, the question arises of, how long must the interruption last? It can be difficult to forecast how long the interruption might affect the target population and facilitators of the intervention. In the case of the Chilean earthquake, some predictions stated that aftershocks might last for well over a year. Data can be collected on mental health and survival needs of both populations to track the severity of responses over time. Based on such data, decisions can be made regarding the length of the interruption. In our experience, after

visits to the schools participating in the study, it was clear that they were trying to return to normality as soon as possible. That information suggested that it was appropriate to continue with the study and, in fact, data collected later proved that this hypothesis was correct.

Finally, in the context of an experimental study, an external shock may have affected the treatment and control groups differently. For example, portions of the treatment population may be more severely affected by the shock, due to residence, different risk or demographic status, or other reasons. If this situation occurs there is need to understand how much the causal inference in the evaluation design may be affected. Post hoc approaches to adjusting for these threats to internal validity must then be considered (for example, Barnard et al., 2003; Krueger 1999).

The specific situation of the earthquake in Chile did not severely affect the city of Santiago. Thus, it seemed reasonable to continue with the experimental study, provided the collection of additional data to understand the interplay between the shock and claims of causality. Furthermore, it was necessary to develop a quick evaluation of the situation in a context of fluid communication. However, this may not be the case with more radical external shocks, such as in armed conflicts or famines (Burde 2008). In these cases, the shock may disproportionately affect geographic areas or parts of the program or evaluation. Here, evaluators have to think about survival instincts taking over for those geographic areas or particular segments of the target population.

The story of the UBC evaluation may have been different if the earthquake had been a different kind of shock. It is easy to imagine scenarios and think about potential ways of dealing with an impact evaluation if, for example, this initiative had taken place in regions most affected by the earthquake; if the disaster was man-made; if the onset of the event was staggered across time or geographic area; or if the disaster only affected one municipality in a given cohort. The deliberative team effort to pose and consider a series of questions regarding the effects of the shock on the intervention and evaluation, and the quick response for collecting information to decide how to proceed with the program and evaluation, are two important factors to consider in cases in which an unanticipated shock appears in the midst of an impact evaluation.

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Bios

Lorenzo Moreno is a senior researcher at Mathematica. He designs and implements large-scale evaluations of social and healthcare programs in the United States and Latin America. His areas of interest include health IT policy, early childhood health and education issues, and international economic development.

Ernesto Treviño is deputy director of the Center of Comparative Education Policies at Universidad Diego Portales, Santiago, Chile. He develops large-scale evaluations for education in Latin America. His research concentrates on equality of educational opportunities through the improvement of teacher practices.

Hirokazu Yoshikawa is Professor of Education at the Harvard Graduate School of Education. He conducts work on how public policies, especially those related to immigration, parental employment, and early childhood care and education, affect child development.

Susana Mendive is postdoctoral fellow at the Harvard Graduate School of Education and Assistant Professor in the School of Education at Pontificia Universidad Católica de Chile. Her research interests focus on how several social interaction processes affect early cognitive and language development (both in family and school

contexts), and how implementation variables influence the impact of educational programs.

Joaquín Reyes is assistant researcher on the UBC's Impact Evaluation's and part-time professor at the School of Education from Universidad Diego Portales. His interests focus evaluation methods and improvement of teacher practices through research.

Felipe Godoy is assistant researcher on the UBC Impact Evaluation's and part-time professor at the School of Education, Universidad Diego Portales. His research interests include impact evaluation in preschool education, especially in experimental methodological designs.

Francisca del Río is associate Professor at the School of Education, Universidad Diego Portales. Her work focuses on preservice teacher training and children cognitive development, especially the development of social cognition.

Catherine E. Snow is the Patricia Albjerg Graham Professor at the Harvard Graduate School of Education. She works on language and literacy development, focusing on the precursors to successful reading comprehension and interventions to support struggling adolescent readers.

Diana Leyva is UBC's project director since August 2010. She is currently a postdoctoral fellow at Harvard Graduate School of Education and Harvard Center on the Developing Child. Her work focuses on parenting and literacy in Latino and low-income communities.

M. Clara Barata is a doctoral candidate at the Harvard Graduate School of Education devoting her dissertation work to the study of executive function skills in Chilean preschoolers and the relationship of these skills to school readiness. She has been a member of the UBC evaluation team since 2007.

MaryCatherine Arbour is a Senior Research Associate at the Center on the Developing Child. She is also Associate Physician for Research at the Division of Global Health Equity of Brigham and Women's Hospital and a faculty member at Harvard Medical School.

Andrea Rolla is a Senior Advisor on Early Childhood Development for the Chilean Ministry of Education's Center of Studies. She is currently working on how research can inform public policy in early childhood at a national level.