

In memory of ALAN KRUEGER:

A brilliant economist who revolutionized and humanized the field of Economics and the Economy*

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Humanism. In a world full of arrogant and aggressive people, **Alan Krueger** shone like a star flashing kindness, creativity, humbleness, honesty, elegance, generosity, intelligence and wisdom, while revolutionizing and humanizing the field of economics and the economy. Together with other economists and co-authors, such as Joshua Angrist (MIT), Orley Ashenfelter (Princeton) and David Card (Berkeley), he carried out the *credibility revolution* in empirical analysis, putting the emphasis on the so-called *identification strategy* (or how to recover the parameter of interest that governs a relationship between two variables).ⁱ But Alan was a *humanist revolutionary* too: he made feel good those around him, regardless of whether they knew him or not, including his students but also low-wage workers whose lives were positively affected by rises in the minimum wage, among other economic policies, which were influenced by his path-breaking research.

Academy and public service. Alan was a brilliant academic and a true public servant, who believed in being able to help others through economic policies based on the best available evidence, fruit of his passionate and objective analysis of very diverse topics: labor market, education, inequality, technological progress, terrorism, music, measures of individual well-being, use of time, and many others. His concern for understanding the determinants of individual well-being, particularly among less-favored individuals, is perhaps the link that unified each of these topics. If we add to this thirst for understanding his amazing capacity for economic analysis, based on his excellent intuition, his extensive statistical knowledge and his great humanism, it is not surprising that he had an enormously positive influence on the real economy during his time as a public servant for different US governments, that of Bill Clinton in the nineties, and that of Barack Obama more recently.

The well-being of people and the importance of data. His economic studies focused primarily on both understanding the various determinants of individual well-being and finding the tools to perform the proper transformations required to radically affect in a positive way the lives of millions of people. To this end he used all kinds of data: from census data, to *twins'* data, to telephone surveys. Alan pushed his students to collect their own data and boosted funding opportunities to help them in such an endeavour. For example, Alan promoted the funding of the Acayucan Standards of Survey (in Mexico) that I and my friend and co-author Marco Gonzalez-Navarro (Berkeley) run in 2006 and 2009 to measure the impact of infrastructure (paving of streets) on the well-being of their inhabitants.ⁱⁱ

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The use of natural experiments to infer causal effects in non-experimental settings. When evaluating the causal effect of a variable of interest, such as the minimum wage or the level of schooling, Alan emphasized the use of *natural experiments* – situations where the group that is affected by the variable of interest is determined by nature (for example, having an identical twin) or by other factors beyond the control of the experimenters (for example, a new reform) – in his studies since the late 80s and early 90s. Natural experiments mimic *randomized controlled trials* (which at that time were carried out mainly in medicine) in complex environments such as the labor market or the education system. Alan’s studies are the basis for most of the empirical work that has been carried out since the late 90s to the present day, and which focuses on the *identification* of the effects of interest.

The effect of the minimum wage on employment. My first contact with Alan Krueger was in 2001, when I read his book with David Card on the new economics of the minimum wageⁱⁱⁱ during the preparation of my undergraduate thesis, under the supervision of Adriana Kugler. This book describes several episodes of increases in the minimum wage and their impact on employment in the US, including the episode analyzed in his seminal article with David Card.^{iv} In Econ 101 we are told that, *ceteris paribus*, in a competitive labor market, an increase in the minimum wage generates a reduction in employment. Alan (in collaboration with David Card) set out to validate this prediction using a *natural experiment*: the minimum wage increase from 4.25 to 5.05 dollars per hour in the state of New Jersey (NJ), USA, on April 1, 1992.

One way to evaluate the effect of the minimum wage increase on employment is to compare the level of employment in NJ before and after the rise in the minimum wage. This comparison is problematic because it captures two effects: the *effect of the increase in the minimum wage* and a *pure time effect*, due to any other factor that changes before and after April 1. How can we remove the pure time effect and *identify* the effect of the increase in the minimum wage? To answer this question Alan and David Card look at the *difference* in employment levels before and after April 1 in the state of Pennsylvania (PA), a NJ neighboring state, where the minimum wage did not experience any change. The *difference* in employment levels in PA allows them to identify the time effect. Subtracting the *difference* in the employment levels of PA from the *difference* in employment levels of NJ allows them to identify the effect of the minimum wage on employment under a key assumption, namely that employment levels in NJ and PA had evolved in *parallel* in the absence of the increase in NJ’s minimum wage.

Using data from 410 fast food restaurants (311 in NJ and 79 in PA) – which are characterized by employing low-wage workers, the group most likely to be affected by the minimum wage – before (February and March 1992) and after (November and December 1992) of the rise in the minimum wage, the authors find that the increase in the minimum wage *did* not reduce employment. This study is of paramount importance for both academic and social reasons. First, from an economic policy perspective, this study shows that the minimum wage can have positive effects in terms of wages *without* having negative effects in terms of employment. Subsequent minimum wage expansions have been clearly influenced by the findings of Alan and David Card, benefitting millions of low-wage workers. Second, the *identification strategy* used in this study, which uses a double difference, hence the name of the method, *difference(s)-in-difference(s)*, is one of the most-used identification strategies by economists since then.^v

The return to schooling in the labor market. I met Alan in 2003, when I moved to Princeton University to pursue my Ph.D. in Economics. In the academic year 2004-2005 Alan was one of my Labor Economics professors. From 2005 until my graduation in 2008, Alan was my dissertation adviser. During my years at Princeton, I learned that Alan was not only interested in the impact of the minimum wage on employment and the working conditions of low-wage workers, but that he was also concerned about the training of these workers, their human capital, among many other issues, all of them linked to their well-being. Alan studied the impact of workers' educational attainment on their wages in many occasions. According to the *theory of human capital*, education makes workers more productive. The basic prediction of this theory is therefore that workers with more years of schooling earn higher wages in the labor market, what economists call the (pecuniary) return to schooling.

A simple way to try and see what this return is consists in comparing the average wage of workers with a higher educational level (e.g., those with a college degree) to the average wage of workers with a lower educational level (e.g., those who do not have a college degree). The problem with this comparison is that workers with different educational levels can differ in characteristics other than their education: their level of motivation, their ability to concentrate, etc. If these characteristics were observed, one could make the above comparison after adjusting for any differences in these characteristics. Unfortunately, not all the determinants of both schooling and wages are observable. If individuals with higher education are also individuals whose families tend to have more contacts, and having more contacts is associated with higher wages, perhaps the above comparison, even after adjusting for differences in motivation and concentration, will capture two effects: the *effect of a higher level of education* and a *bias* due to the fact that individuals with a higher educational level tend to come from families with more contacts, and having more contacts is associated with higher earnings. Alan tackled this *omitted relevant variable* (or "ability") bias problem on numerous occasions, and did so in very creative ways, using very different information (e.g., information on twins, information on the quarter of birth) and very diverse data sources (e.g., own surveys and census data).

In 1991, Alan, in collaboration with Orley Ashenfelter (Princeton), collected data on 298 *monozygotic* (identical twins) who participated in the world's most important twin meeting held annually in Twinsburg, Ohio, for the purpose of quantifying the return of education in the labor market.^{vi} The idea is that a pair of genetically "identical" twins does not only share the same environment (at least in comparison to a pair of randomly selected individuals from a population), including the same family, but also the same innate ability, among other characteristics that may be relevant and associated with schooling and wages. If one is willing to assume that a pair of *identical* twins with *different* educational levels shares those characteristics related to schooling and wages, the comparison of wages within identical pairs of twins with different schooling levels allows to identify the causal effect of education on wages. The findings from this comparison reveal that an additional year of education implies a salary increase of 12-16%. Once again, many subsequent studies used similar identification strategies when evaluating the rate of return to investment in human capital, comparing sibling or twins.

But the study I would like to highlight in this brief note is his work with Joshua Angrist (MIT), where the authors investigate the causal effect of education (measured in years of schooling) on wages using information about the quarter of birth.^{vii} What is the relevance of the quarter of birth in this context? The role of the trimester of birth in the relationship between schooling and wages arises from the interaction of two types of rules/laws of

the educational system in the US: (1) school age entry rules and (2) compulsory schooling laws. To explain the role of these rules/laws we can consider an example with 2 individuals: Carles (born January 1, 1980) and Oriol (born December 31, 1980). First, suppose that, *regardless* of the month of birth, all children, including Carles and Oriol, begin the first year of school the year they turn 6 years old. Second, suppose that once they turn 16, any student (including themselves) can drop out from high school if wanted, and that both Carles and Oriol want to drop out from high school. As Carles turns 16 on January 1 of 1996, he can drop out from high school earlier than Oriol, who can drop out from high school only after December 31 of 1996. Hence, Oriol is *forced* by the compulsory schooling law to acquire 9 additional months of schooling with respect to Carles (assuming that the summer holiday period lasts 3 months). Now suppose that we have many Oriols and Carles; the difference in the average salary between Oriols and Carles divided by the average difference in schooling between Oriols and Carles (9 months) will allow us to identify the causal effect of an additional year of schooling for the group of Carles and Oriols, that is, for the group of individuals born at the beginning and the end of the year who acquire more or less schooling based on their date (trimester) of birth, under certain assumptions.

Technically, the quarter of birth is an *instrumental variable* for the educational level, and is a *valid instrument*, that is, it allows to identify the previous causal effect, provided that (1) people born in the last quarters of the year have a level of schooling greater than those born in the first quarters of the year (the instrument is *relevant*), and (2) the quarter of birth is not associated with other wage determinants (the instrument is *exogenous*), such as the level of motivation, the ability to concentrate, etc. The use of quarter of birth as an instrumental variable generated a whole discussion in the profession about how important is that the instrumental variable can explain the *endogenous* variable (the level of schooling in this case).

While the *relevance* of the instrument can be directly examined, the same cannot be said about its *exogeneity*. However, one can try to *refute* the exogeneity of an instrument in various ways as the authors illustrated in their paper. For example, investigating if the quarter of birth is correlated with other characteristics (level of schooling of the mothers^{viii}), and at the same time the correlation goes in the same direction as the effect of interest, or investigating whether the quarter of birth predicts wages for the group individuals with college degrees. If the effect of the quarter of birth on schooling is due to compulsory schooling laws, this should only affect individuals who want to drop out from school as soon as possible. Therefore, if the trimester of birth is *exogenous*, we should not find an effect of the quarter of birth on either schooling or wages among students with a college degree. This is exactly what Alan and Joshua Angrist found. This type of *refutability* test, which we find in a study published almost 30 years ago, is a type of placebo analysis used in current applied work.

The study revealed that the simple comparison of average salaries between individuals with high and low levels of schooling produces a very similar result to that based on the use of the quarter of birth as an instrumental variable. In my view, the most important aspect of this study is not the result itself, but the way the method of *instrumental variables* is presented to infer causal effects and the discussion on the underlying assumptions and refutability tests of the same. This study is without any doubt a mandatory reading for anyone who wants to understand how to use instrumental variables. The lessons of this episode in Alan's life are part of today's empirical practice for any economist who works with data.

Humanism, once again. Alan was my professor, adviser and mentor. I learned a lot from him, academically and personally. Alan was always generous with his time, advice and feedback, and always with a smile. I can vividly remember that the door of his office was always open; although I must admit that, most of the time, I did not know what to say or what to ask, due to my lack of confidence in my abilities or lack of knowledge.

But Alan was also a friend. I remember in 2012 his concern about the Spanish crisis and how it could affect my academic work while I was working at the Universidad de Alicante. Shortly after I moved to the United Kingdom, where I accepted an offer from the University of Oxford. In 2016 during the annual congress of the Royal Economic Society in Brighton, and after its plenary session on minimum wages, we talked and he signed me a copy of the 20th anniversary special edition of his book on the new economics of the minimum wage (with David Card).^{ix} As always, good words, expression of gratitude to meet with him and a big smile.

One memory I have very present is from his visit to the Universidad de Alicante in 2008. I get emotional in remembering his words on the way to his taxi the day of his departure: “They really like you here. This is very important.” What was the causal effect of these words on me? As Alan would say, we cannot know without a good *counterfactual*. But I believe their effect was very positive, as the influence he had on everyone who interacted with him, and was inspired by his passion for economics, his smile and his humanity. With Alan’s tragic departure, we run the risk that his revolution stops and our profession becomes darker, less generous, and less human. Let us hope that this does not happen. This would be the best professional tribute to his legacy.



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- ^{viii} Clarke, Damian, Oreffice Sonia, and Climent Quintana-Domeque (forthcoming) “The Demand for Season of Birth.” *Journal of Applied Econometrics*.
- ^{ix} Card, David and Alan Krueger (2015) *Myth and Measurement The New Economics of the Minimum Wage - Twentieth-Anniversary Edition* , Princeton, Princeton University Press.