

# The Effect of Education on the Demographic Dividend

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RESEARCH ON the effect of the population age structure on economic growth has been mainly motivated by the demographic transition from high to low rates of mortality and fertility that most countries are experiencing as they develop. Previous research was focused on the link between population size and economic growth, but the influential work of Bloom and Williamson (1998) introduced age structure into the analysis, finding that this was an important mechanism by which demographic variables affect economic growth. The concept of the *demographic gift*, later re-named as the *demographic dividend*, first appeared in Bloom and Williamson's work to refer to the positive effect that the demographic transition can have on economic growth. During this process, the working-age population temporarily grows faster than the rest. Consequently, per capita income can increase as there are fewer economic dependents in the population. Nevertheless, this effect will vanish some years later, when large youth cohorts reach retirement age, leading to an increase in old-age dependency ratios, i.e., population aging.

The demographic transition has coincided with a significant educational expansion that occurred in virtually every country during the twentieth century, especially after the 1960s. Certainly, important differences remain between areas, but all world regions show general improvements in education (UNESCO 2011). This means that the empirically observed effects of population age structure on economic growth are probably influenced by improvements in the education level of the population.

Two strands of literature analyzing the determinants of economic growth have evolved separately in recent decades. On the one hand, research on the demographic dividend seeks to elucidate the effects of the population age structure on economic growth, but without paying specific attention to changes in educational level, only in the investment in human capital of children (Lee and Mason 2010; Mason, Lee, and Jiang 2016). On the other hand, a longstanding branch of economic research seeks to study the returns to education and the effect of educational attainment on

economic growth but without special regard to the population age composition (Johnes and Johnes 2004). Papers by Lutz, Crespo-Cuaresma, and Sanderson (2008) and Crespo-Cuaresma, Lutz, and Sanderson (2014) act as a bridge between the two research lines, as the authors try to disentangle the roles of age structure and education in economic growth using panel data. These authors estimate a macroeconomic growth model using a newly available dataset on human capital, containing information about educational attainment distribution by age and sex for more than 100 countries for the period 1980–2005.<sup>1</sup> They conclude that, when correcting for educational expansion, the effect of population age structure on GDP per capita is reduced significantly—that is, the demographic dividend is mainly an education effect. Education and age composition of the population are treated as two separate factors in the regressions, as if the education level of the population was unrelated to the age structure of the same population.

In our study, we link education attainment to the evolution of the population age structure using a different method. We propose an extension of the methodology developed by Mason (2005) and Mason and Lee (2006), in order to decompose the growth in the support ratio—the demographic dividend—into two components: age and education. These authors combined demographic data with the age profiles of consumption and labor income, estimated following the National Transfer Accounts (NTA) method. We follow the same strategy, taking it one step further. We first estimate the NTA age profiles by education level and then adapt the method to incorporate education variability. Second, to illustrate the potentialities of this methodological extension, we perform a simulation exercise for Mexico and Spain, for which we were able to construct the NTA profiles by level of education.<sup>2</sup> The countries represent two distinct contexts in terms of demographic transition and educational achievements of their populations. Our simulation starts in 1970 and projects it into the future. We are thus able to evaluate the impact of population age structure on the support ratio while taking into account that changes in education also influence the level of production and consumption.

### Decomposing the demographic dividend by age and education level

Following Mason (2005), the concept of the demographic dividend can be formally derived starting from the following decomposition of per capita income at year  $t$ :

$$\frac{Y(t)}{N(t)} = \frac{W(t)}{N(t)} \frac{Y(t)}{W(t)} \quad (1)$$

with  $Y$  being income,  $N$  total population, and  $W$  working-age population (hereafter workers). The first term on the right-hand side, the ratio of

workers to total population, represents the support ratio (*SR*). The second term on the right-hand side is output per worker (labor productivity, *Pr*). Hence, income per capita depends on the support ratio and productivity. Expressing Equation (1) as growth rates (using the operator *g*), one can state that changes in the support ratio and in productivity growth determine per capita income growth:

$$g\left(\frac{Y(t)}{N(t)}\right) = g(SR) + g(Pr) \quad (2)$$

The demographic dividend is captured by the evolution of the support ratio. Using regression analysis, Bloom and Williamson (1998) concluded that the demographic transition contributed to the so-called economic miracle observed in East Asia over the period 1965–1990. Kelley and Schmidt (1996) and Bloom and Canning (2003) also conducted empirical studies using cross-country aggregate data. Mason (2005) and Mason and Lee (2006) derived an alternative estimation process for the evolution of the support ratio, combining demographic and economic information. By using the per capita age profiles of labor income and consumption, they obtained effective consumption (*C*) and effective production (*L*) instead of *N* and *W* in Equation (1). With *c<sub>i</sub>* and *ly<sub>i</sub>* being the per capita age profiles of consumption and labor income, respectively, *C* and *L* can be obtained as follows:

$$C(t) = \sum_i N_i(t) \cdot c_i \quad (3)$$

$$L(t) = \sum_i N_i(t) \cdot ly_i \quad (4)$$

where the summation is over ages *i*.

In this way, the pure demographic support ratio in Equation (2) is redefined as an economic support ratio (*ESR*), as it considers not only demographic effects of population age structure, but also economic variables such as labor and consumption patterns. Estimates of the demographic dividend based on the *ESR* are available for many countries (Mason 2005; Mason and Lee 2006; Oosthuizen 2015; Patxot et al. 2011a; Prskawetz and Sambt 2014; Mejía-Guevara and Partida Bush 2014; Rosero-Bixby 2011). Results show that, for most developed countries, the demographic dividend started around the 1970s and lasted for about three decades, but some differences can be observed depending on the specific demographic and economic characteristics of each country.

*ESR*, as the ratio of effective production to effective consumption, can also be expressed in terms of growth rates:

$$g(ESR) = g(L) - g(C) \quad (5)$$

To consider the effect of education in the estimation of the demographic dividend, we further break down Equations (3) and (4) by educational group, represented by  $j$ :

$$C(t) = \sum_j C_j(t) = \sum_i \sum_j N_{ij}(t) \cdot c_{ij} \quad (6)$$

$$L(t) = \sum_j L_j(t) = \sum_i \sum_j N_{ij}(t) \cdot ly_{ij} \quad (7)$$

Once the economic profiles have been differentiated by both age and education, we can measure the contribution of each of these two factors to the demographic dividend (estimated as the change in the *ESR*).

We separately decompose the annual growth rate of production ( $L$ ) and consumption ( $C$ ) into an age effect ( $A$ ) and an education effect ( $E$ ), applying the method of Das Gupta (1993), adding a rate effect ( $R$ ), as follows (see Appendix for details<sup>3</sup>):

$$g(L) = (R_L + A_L + E_L)/L(t) \quad (8)$$

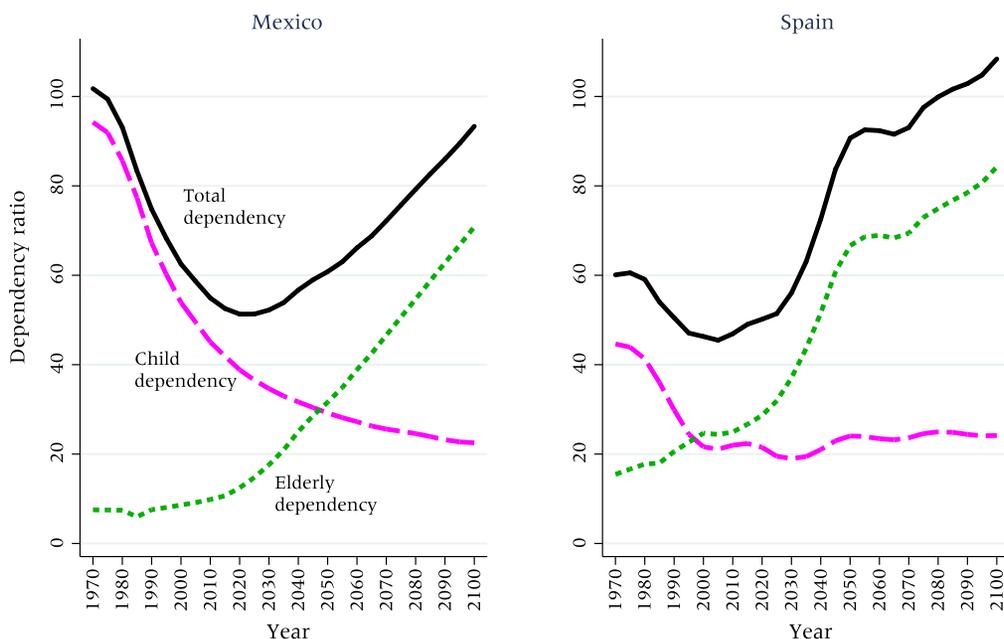
$$g(C) = (R_C + A_C + E_C)/C(t) \quad (9)$$

Each of the effects is estimated observing how  $L$  (or  $C$ ) changes annually when the other two factors remain constant. For example, the age effect on labor income ( $A_L$ ) is obtained keeping constant the labor income profile and the population distribution by level of education, while only population age structure varies. By substituting Equations (8)–(9) in Equation (5) and rearranging terms, we obtain the three effects on *ESR* growth (rate, age, and education), corresponding to production and consumption.

To carry out the decomposition, we derive age profiles of consumption and labor income by education level and apply them to the population over several years. Population data, therefore, also need to be disaggregated by age and education level. We show the decomposition for Mexico and Spain from 1970 to 2100, taking one base year for the economic profiles. This implies that we will capture both education and age effects, but not the rate effect shown in Equations (8) and (9).

### Population data by level of education

We used population projections by level of education, available from the Wittgenstein Centre for Demography and Global Human Capital (WICD).<sup>4</sup> WICD has produced, for the first time, projections of population by educational level, age, and sex for 195 countries for the period 1970–2100, using exhaustive information and analyses of recent trends in fertility, mortality, migration, and educational level for all areas of the world (Lutz, Butz, and KC 2014; Springer et al. 2015). They also consider other scenarios in their

**FIGURE 1** Population dependency ratios in Mexico and Spain 1970–2100

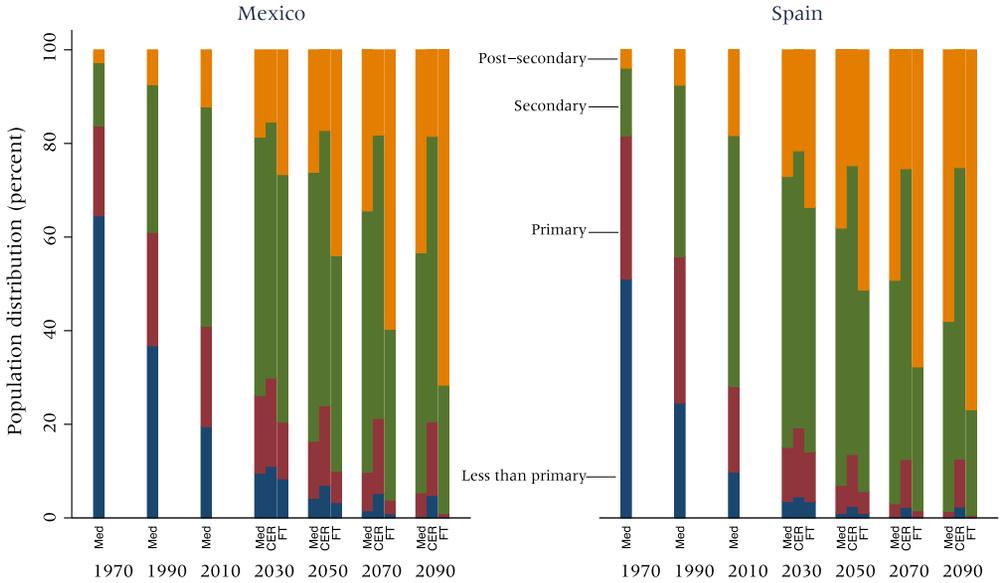
SOURCE: Authors' calculations based on WICD (2015).

projections. We use two of them for the sensitivity analysis, the Constant Enrollment Rate (CER) and the Fast Track (FT) scenarios. The CER scenario assumes that enrollment rates remain constant over time in both Mexico and Spain from 2015 onward; therefore, no significant improvements in education level are expected beyond the coming decades. On the other hand, the FT scenario assumes that enrollment rates improve faster than in the central projection.

To observe the evolution of the age structure in both countries, Figure 1 shows the dependency ratios (using data by age and year) obtained from WICD for 1970–2100. First, child dependency has experienced a clear decline in both countries but with different patterns. The demographic transition started later in Mexico than in Spain, but it has been much more pronounced in the former as the initial level of fertility was higher. At the beginning of the century child dependency still exceeded 50 percent, but it will continue to decrease until 2050, after which it will stabilize at around 25 percent. In Spain, child dependency reached its minimum, at slightly above 20 percent, in the early 2000s and is expected to remain at around that level until 2040. After that year, it will increase to 25 percent and will remain there for the rest of the century.

Second, demographic patterns also differ regarding elderly dependency. In Mexico, it will increase especially after 2030 and will continue to grow over the rest of the century. In Spain, it starts to grow earlier and will

**FIGURE 2 Distribution of the population by education level in Mexico and Spain, 1970–2100, according to different education projection scenarios**



NOTE: Med = medium (baseline) scenario; CER = Constant Enrollment Rate scenario; FT = Fast Track scenario.  
SOURCE: As in Figure 1.

peak at around 69 percent by 2050, a level that Mexico will never reach during the period. The process is strongly driven by the evolution of the fertility rate, which was 2.2 in Mexico in 2015 (CONAPO 2015), compared with only 1.3 in Spain in 2013 (INE 2015). Projections for Mexico suggest that the fertility rate will remain higher than in Spain, and consequently the increase in its elderly dependency ratio will be slower (UN 2015). Finally, during the first part of the period analyzed—until 2010 in Spain and 2030 in Mexico—the total dependency ratio is mainly driven by the evolution of child dependency. Conversely, elderly dependency will become the main driver of total dependency in the future. Note also that the minimum level of the total dependency ratio expected in Mexico (48 percent in 2030) is slightly higher than in Spain (44 percent in 2005–9).

Figure 2 displays population projections by level of education (percent of adult population in each education level) for the baseline scenario (the medium case), as well as the alternative scenarios (CER and FT) for the period 1970–2090. Mexico and Spain have seen great improvements in their level of education in recent decades, reducing the share of adults with less than primary education and increasing the proportion with higher education. Nevertheless, differences between the two countries remain. According to the OECD (2013), in 2011 Mexico was clearly behind the OECD average in terms of people aged 25–34 who had completed at least upper secondary education (55 percent in Mexico vs. 82 percent in OECD)

and who had attained tertiary education (23 percent vs. 39 percent). Those figures were higher in Spain (65 percent aged 25–34 with upper secondary education, 39 percent with tertiary education) (OECD 2014). According to projections by Lutz, Butz, and KC (2014), the differences between the two countries will persist in the future. For example, adults in Spain with less than primary school will make up less than 3 percent of total population in 2035, while this level will occur 20 years later in Mexico. By 2100, 53 percent of Spaniards and 41 percent of Mexicans will have post-secondary education.

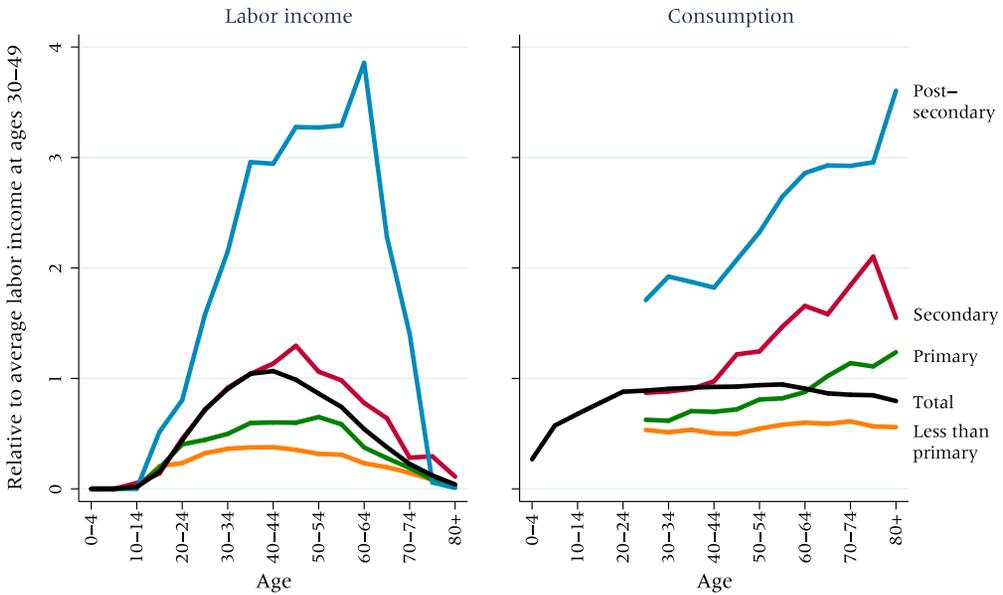
When observing the two alternative scenarios, important differences between educational attainment in Mexico and Spain remain. According to the CER scenario, however, educational attainment of the population stops improving after 2050 in both countries. In the FT scenario, proportions with post-secondary education increase faster, and proportions with primary or less than primary education are reduced to very low levels. Nevertheless, by 2090, Spain continues to have a higher proportion of the population with post-secondary education than Mexico.

### Age profiles of consumption and labor income by level of education

We briefly describe the procedure to construct economic profiles by age and educational level for Mexico and Spain. We are interested in two profiles: labor income and consumption. The consumption profile will be used to obtain the number of effective consumers (Equation 3), and the labor income profile to estimate the number of effective producers (Equation 4). The difference between labor income and consumption age profiles defines the lifecycle deficit (*LCD*) in the NTA methodology. The *LCD* shows how production and consumption vary over the lifecycle. Typically, individuals consume more than they produce at the beginning and the end of their lives, and the opposite occurs for working-age individuals. The length of these three periods, together with the amount of the corresponding deficit (consumption higher than labor income) or surplus (consumption lower than labor income), varies among countries (Lee and Mason 2011).

We followed the NTA methodology (UN 2013) to construct economic profiles estimated from surveys and official data and then adjusted to aggregate data from National Accounts. The labor income profile represents the sum of earnings and self-employment income profiles in the total population by age and education level, and the consumption profile includes both public and private consumption. We go beyond the standard NTA methodology by differentiating age profiles by education level. We consider four levels of education: less than primary, primary completed, secondary completed, and higher education.<sup>5</sup>

**FIGURE 3 Economic profiles—labor income and consumption per capita—by individual level of education in Mexico, 2004**

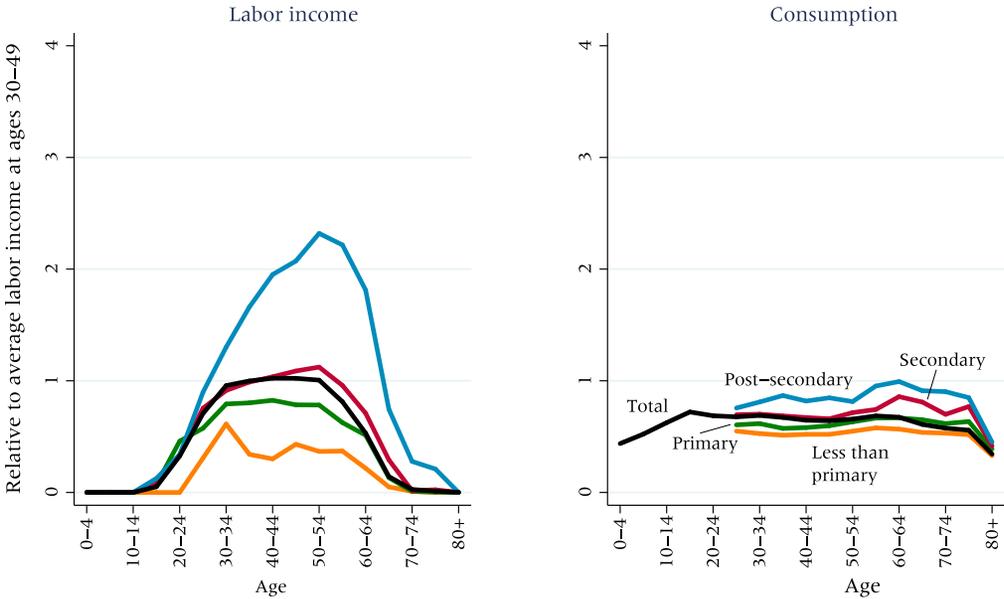


SOURCE: Authors' calculations.

Data for Mexico are from 2004. Micro data on labor and private consumption are from the Income and Expenditure Survey (ENIGH) (INEGI 2015), while public consumption data come from administrative records (SHCP 2004). Data for Spain are for 2006. Private consumption data come from the Household Budget Survey (INE 2006), labor income data are extracted from the EU-SILC (EUROSTAT 2007), and public consumption data come from various public administration statistics (INE, IGAE). Details on the construction of profiles for both countries are given elsewhere (Mejía-Guevara 2011, 2014 for Mexico; Patxot et al. 2011a, 2011b for Spain).

Figures 3 and 4 show the per capita age profiles of labor income and consumption by level of education for Mexico and Spain, respectively. To make the profiles comparable, they have been divided by the average (total) labor income for ages 30–49 in each country. Although with differences, both average economic profiles show the typical shape by age: while consumption remains stable over the lifecycle for adults, labor income is clearly concentrated in the middle years of working age (Lee and Ogawa 2011; Tung 2011). Nevertheless, the differentiation of those profiles by educational attainment shows significant new features. First, in both countries labor income profiles display greater differences than consumption profiles; that is, labor income is more unequal according to level of education than consumption. In Mexico, the labor income profiles peak at very different age groups according to education level, peaking at 65–69 for the highest

**FIGURE 4 Economic profiles—labor income and consumption per capita—by individual level of education in Spain, 2006**



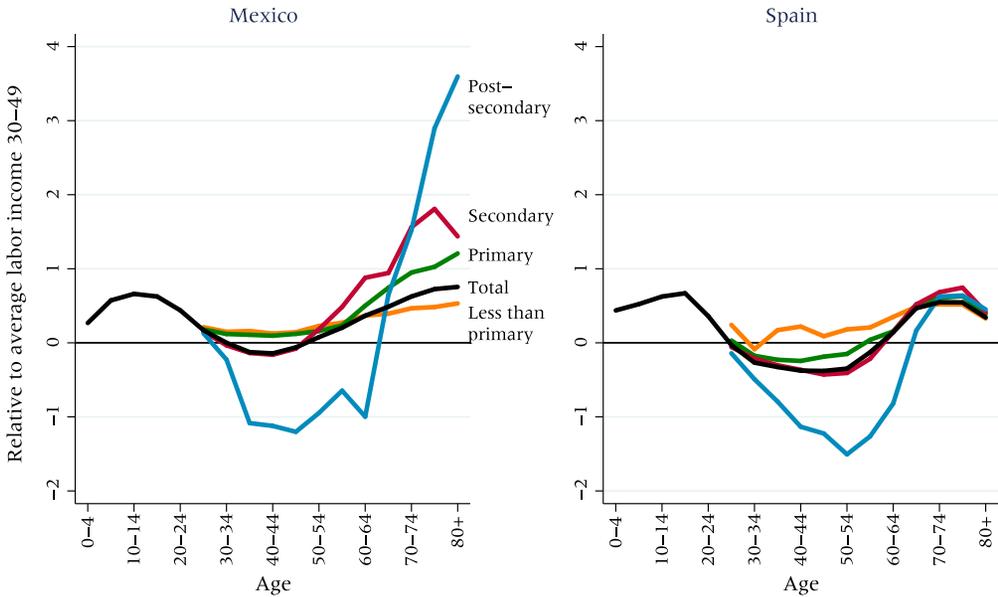
SOURCE: Authors' calculations.

education level and at 35–39 for individuals with less than primary education. Inequality in profiles by educational attainment in Mexico is clearly observed, where per capita labor income in post-secondary education at ages 30–54 is over 3 times the average labor income at 30–49. In Spain, the labor income profile peaks at around ages 50–54 for higher education levels (post-secondary and secondary education), while it peaks at younger ages for lower levels of education. Although inequality in Spain is also clear, it is smaller than in Mexico. On average, labor income of individuals at ages 30–59 with post-secondary education in Mexico is 8.6 times that of the individuals with less than primary education, compared to 5.1 times in Spain.

Second, the differences in consumption profiles by level of education are again clearly higher in Mexico. Consumption of highly educated individuals is more than double the average consumption, while consumption of the less educated is half that of average consumption. For Spain, consumption profiles by level of education are much more uniform, and consumption of highly educated individuals is 60 percent higher than consumption of less educated individuals at ages 30–59. The average consumption profile observed in Spain among persons aged 30–49 is 66 percent of the average labor income for ages 30–49, significantly lower than in Mexico, where it is around 90 percent.

The per capita lifecycle deficit (*LCD*) profiles for both countries are shown in Figure 5. In general, Mexico has higher deficits than Spain

**FIGURE 5** Lifecycle deficit profiles per capita by level of education in Mexico and Spain



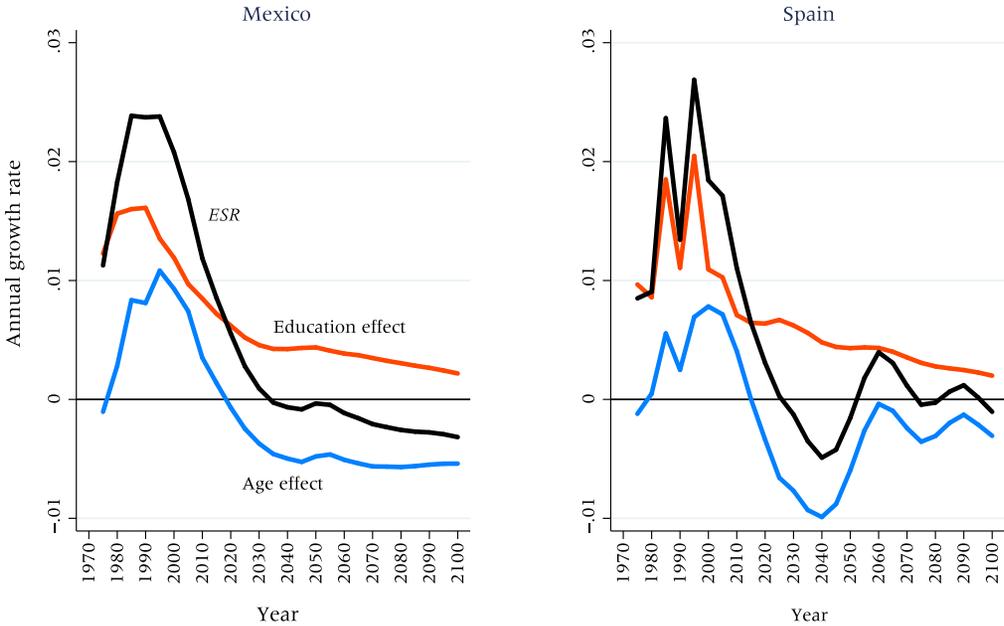
SOURCE: Authors' calculations.

because, as seen in previous figures, its consumption profiles are clearly higher than Spain's at every level of education, while labor income profiles are not. In Mexico, only individuals with at least secondary education can generate a surplus (labor income higher than consumption) during their lifecycle. This surplus is much more significant for individuals with post-secondary education and very modest for those with secondary schooling. On the other hand, people with less than secondary education consume more than they produce over the whole lifecycle. In Spain, the picture is slightly more favorable: individuals with primary education already experience a surplus during part of their working-age years.

### The role of education in the demographic dividend

We now present the results of our simulation exercise to evaluate the impact of education on the support ratio in the period 1970–2100. We apply the profiles of consumption and labor income to the population projections by age and level of education and observe how the support ratio evolves over time. Figure 6 shows trends in the demographic dividend (defined as the rate of growth of the support ratio) in Mexico and Spain, disentangling the education and age effects. As explained above, the education effect captures the impact on the demographic dividend of changes in population

**FIGURE 6** Decomposition of the demographic dividend (ESR) by age and education in Mexico and Spain, 1970–2100



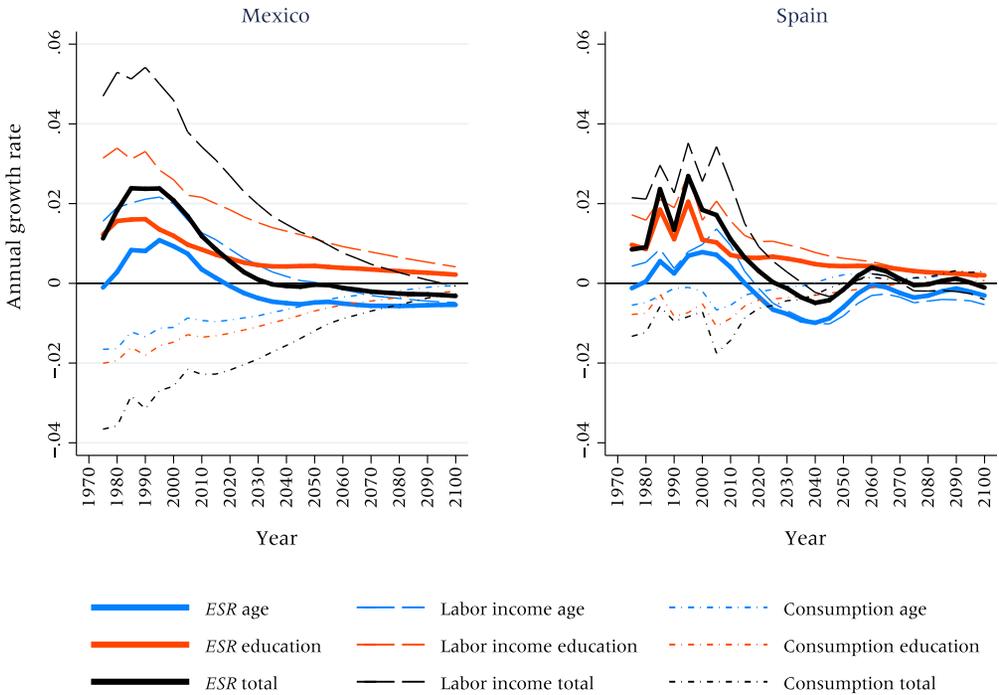
SOURCE: Authors' calculations.

composition by education level, while the age effect estimates the impact of changes in population age structure. In Mexico, the support ratio attained its highest growth rate in 1985 after which it declines steadily until it becomes negative in 2040 and remains so for the rest of the century. In Spain, the support ratio peaks a decade later—in 1995–99—but decreases more quickly, becoming negative by 2030–34. Negative values are clearly higher in Spain than in Mexico, but they last until 2055, when the support ratio becomes positive again for a period of 20 years.

The estimated positive age effect in both Mexico and Spain will last until 2020 after which it will remain negative for the rest of the century. In Spain, the negative age effect will peak in 2040 (coinciding with the full retirement of the large youth cohorts) and will rise from then on. In Mexico, the negative effect of age is never as important as in Spain because of the different time path of the two countries' demographic transition. While the age effect closely follows the trend of the total dependency ratio, the education effect is positive throughout the period for both Mexico and Spain as the education level of both populations continues to increase. Hence, the growth of the support ratio will remain positive if the positive education effect is higher than the negative age effect.

Although Spain's population is expected to reach higher education levels than Mexico's, it also has a much more negative age effect, which retards

**FIGURE 7** Decomposition of the demographic dividend into labor income and consumption growth by age and education: Mexico and Spain, 1970–2100



SOURCE: Authors' calculations.

the positive effect of education. Thus, while education expansion can partly overcome the negative impact of an increasing dependency ratio on the demographic dividend, the population age structure remains crucial in the evolution of the *ESR*.

As described earlier, *ESR* is the ratio of effective production (labor income) to effective consumption in a given economy. That is, total *ESR* growth is the difference between the growth of effective labor income and effective consumption (Equation 7). Figure 7 shows the growth rate of the *ESR* (both the age and the education effects) decomposed by the changes in labor income and consumption separately. We represent consumption growth in negative terms (meaning that its impact on the total *ESR* is negative). Interestingly, education and age effects on consumption growth are very similar, while the education effect on labor income is clearly higher within the entire period. That is, the education effect on labor income seems to be the main factor behind the positive impact of education on the demographic dividend.

As mentioned above, the demographic dividend measures the effects of changes in age structure and educational attainment on economic growth. To explore this relationship, Table 1 shows past trends in the

**TABLE 1 GDP growth and the demographic dividend decomposed by age and education, Mexico and Spain, 1970–2015**  
(percentage average annual growth rates)

Period	GDP per capita	GDP per consumer	Economic Support ratio	Education effect	Age effect	Labor		Consumption age effect
						Income education effect	Income age effect	
<b>Mexico</b>								
1970–75	6.54	4.45	1.13	1.23	-0.10	3.14	1.56	2.00
1975–80	5.15	3.52	1.83	1.56	0.28	3.39	1.90	1.64
1980–85	1.94	0.39	2.38	1.60	0.83	3.11	2.01	1.22
1985–90	2.15	0.43	2.37	1.61	0.81	3.31	2.11	1.34
1990–95	1.66	-0.01	2.38	1.35	1.08	2.84	2.16	1.57
1995–2000	5.05	3.73	2.08	1.19	0.93	2.60	2.00	1.47
2000–05	1.42	1.50	1.69	0.97	0.74	2.21	1.59	1.29
2005–10	2.86	2.37	1.19	0.85	0.35	2.16	1.27	1.35
2010–15	2.77	1.05	0.85	0.72	0.14	2.00	1.09	1.32
<b>1970–2015</b>	<b>3.27</b>	<b>1.92</b>	<b>1.76</b>	<b>1.23</b>	<b>0.56</b>	<b>2.75</b>	<b>1.74</b>	<b>1.59</b>
<b>Spain</b>								
1970–75	4.46	4.65	0.85	0.97	-0.12	1.72	0.43	0.78
1975–80	1.52	1.60	0.90	0.86	0.05	1.58	0.53	0.48
1980–85	1.07	1.21	2.37	1.85	0.55	2.10	0.86	0.31
1985–90	3.90	4.04	1.34	1.11	0.25	1.90	0.37	0.13
1990–95	1.51	1.37	2.69	2.05	0.69	2.73	0.79	0.10
1995–2000	3.41	3.44	1.84	1.09	0.78	1.58	0.97	0.20
2000–05	2.81	2.71	1.71	1.03	0.71	2.06	1.37	0.67
2005–10	1.06	0.86	1.11	0.71	0.41	1.56	0.95	0.55
2010–15	-0.54	-0.81	0.65	0.64	0.00	1.20	0.30	0.30
<b>1970–2015</b>	<b>2.12</b>	<b>2.10</b>	<b>1.53</b>	<b>1.17</b>	<b>0.38</b>	<b>1.87</b>	<b>0.75</b>	<b>0.37</b>

SOURCE: Authors' calculations. GDP data from OECD statistics.

demographic dividend decomposed for age and education, together with the annual GDP growth observed, both in per capita and per effective consumer terms.<sup>6</sup> Mexico registered average annual growth in the support ratio of 1.76 percent over the period 1970–2015, as a result of a positive age structure and especially a very favorable education effect. This is observed when comparing the impact of education on labor income growth (2.75 percent), which is clearly higher than the impact on consumption growth (1.59 percent). However, although annual GDP per capita growth was 3.27 percent, GDP per effective consumer grew by only 1.92 percent, owing to the unfavorable relation between labor income and consumption. Of utmost importance, during the most favorable period for *ESR* growth (1980–95), this was well above the GDP growth. This result indicates that Mexico was unable to take full advantage of its favorable demographic and educational circumstances.

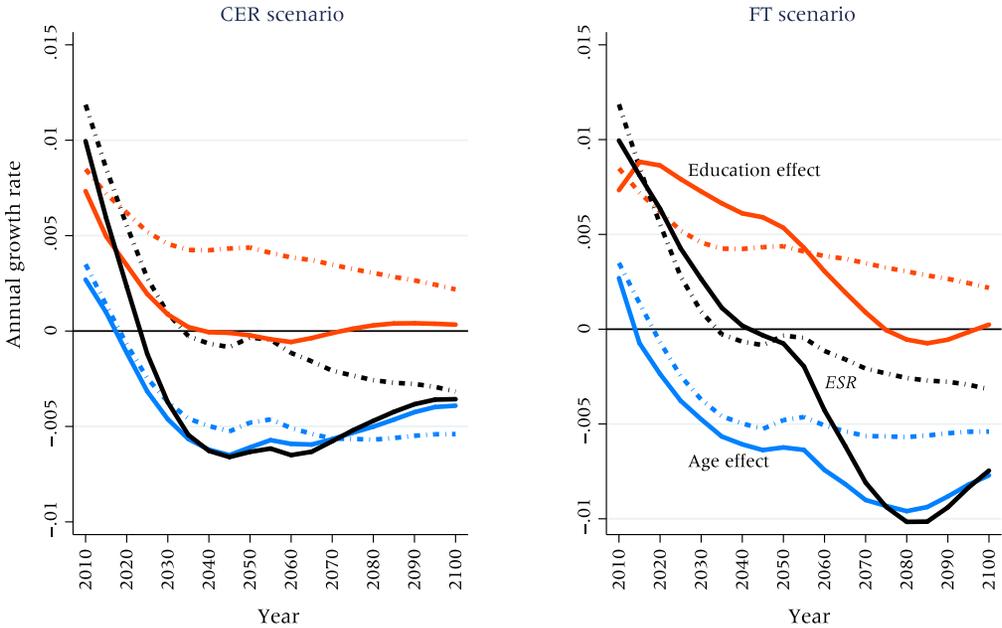
In Spain, the demographic dividend (*ESR*) was also positive (1.53 percent) throughout the period 1970–2015, although the age effect is zero in the last years. This accounted for 73 percent of GDP growth per effective consumer. As in Mexico, the impact of education on the support ratio is mainly explained by the higher effect of education on labor income growth (1.87 percent), compared to consumption growth (0.73 percent). However, during some periods (1980–85, 1990–95, and 2005–15), growth in Spain's economy was clearly less than growth in the demographic dividend, meaning that the opportunities offered by population structure in terms of age and education were missed. Hence, it seems that in the past Spain, and especially Mexico, were unable to fully benefit from their significant demographic dividend. This is particularly worrying given that the demographic dividend will be much lower, and even negative, in the future.

To evaluate the robustness of our results, we perform two sensitivity exercises. First, we evaluate the impact of the education projections by using two alternative scenarios, as described earlier. Second, we evaluate the impact of the economic profiles of consumption and labor income by transposing the profiles estimated for the two countries.

### Alternative education projection scenarios

We re-estimate our results for the demographic dividend decomposed with two alternative scenarios of population distribution by level of education, also available in WICD (2015). The CER scenario assumes very little improvement in the educational attainment of both countries, while the FT scenario assumes a faster education expansion than in the central projection. Both alternative scenarios use the same assumptions as the baseline scenario except for the education enrollment rates. However, because demographic components depend on the education level of the population, the two alternative scenarios produce different population age structures.

**FIGURE 8 Demographic dividend (ESR) in Mexico with alternative education projection scenarios**

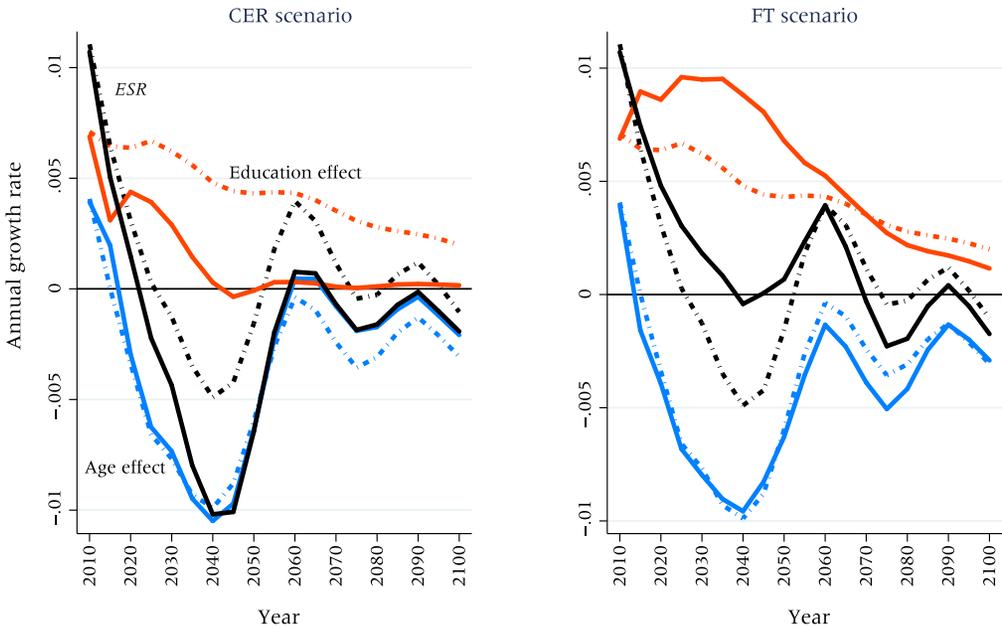


NOTE: Solid lines indicate CER (left) and FT (right) scenarios; dashed lines indicate baseline scenario. See text for details. SOURCE: Authors' calculations.

Results obtained with the two alternative education scenarios, together with our baseline estimation, are shown in Figure 8 for Mexico and Figure 9 for Spain. Solid lines refer to the alternative scenarios (CER and FT), dashed lines to the baseline scenario. As expected, in the CER scenario the education effect is clearly lower for both countries, becoming zero around 2040 in both cases and remaining close to that level thereafter. The decline of the education effect means that the demographic dividend (positive *ESR*) becomes dependent mostly on the age effect and turns negative earlier and much deeper than in the baseline scenario. In the FT projections, on the other hand, the education effect is much more positive during the first half of the projection. After 2060 in Mexico and 2070 in Spain, the education effect is lower than in the baseline scenario, probably because once a majority of the population is already enrolled in school until tertiary education, improvements are necessarily smaller. Therefore, the consequences are positive in the medium term, but turn negative thereafter. In Mexico under the faster education expansion, the demographic dividend remains positive until around 2040, but then the age effect decreases sharply, driving the *ESR* to very negative values beginning around 2060. In Spain, the negative *ESR* from 2020 to 2050 almost disappears.

Overall, the results of both scenarios demonstrate that improvements in the educational attainment of the population are crucial in the evolution

**FIGURE 9 Demographic dividend (ESR) in Spain with alternative education projection scenarios**



NOTE: Solid lines indicate CER (left) and FT (right) scenarios; dashed lines indicate baseline scenario. See text for details.  
SOURCE: Authors' calculations.

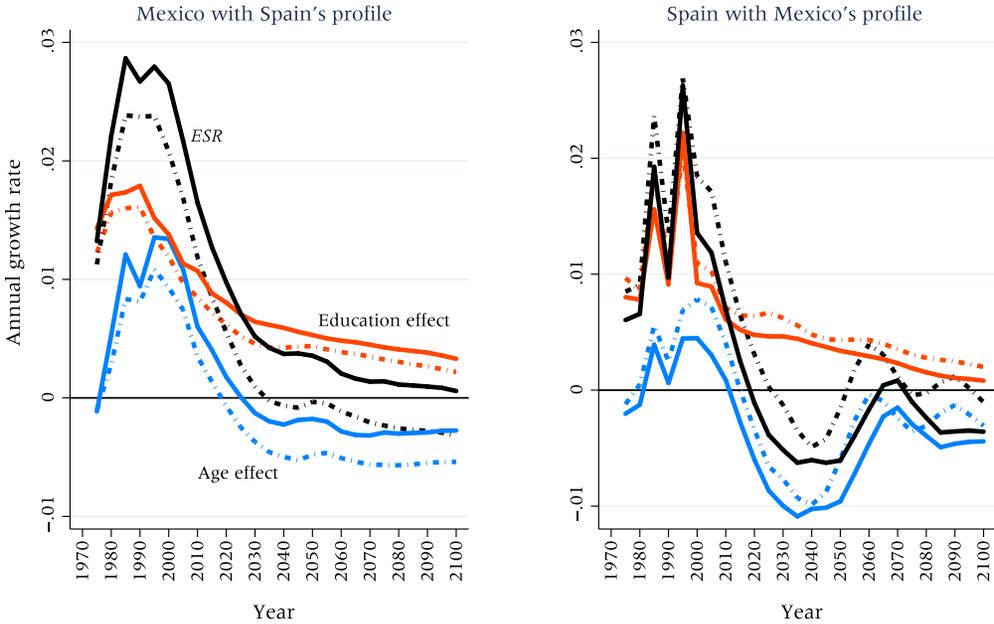
of the demographic dividend, both through the direct impact of education and through its effect on the demographic components influencing the age effect.

### The effect of the economic profile

As we noted earlier, economic profiles of labor income and consumption (and hence of *LCD*) differ significantly by level of education within each country, but there are also disparities between the two countries. Spain has more favorable profiles in terms of *LCD*, as its relative consumption profiles are clearly lower than Mexico's for all education levels, while its relative labor income profiles are slightly higher. To evaluate the impact of the economic profiles on the demographic dividend, Figure 10 shows the estimated trend in the demographic dividend in Mexico under the assumption that it has the economic profile of Spain, and vice versa. The solid lines refer to the changed profiles simulation and the dashed lines to the baseline.

The results show that both age and education effects are influenced by economic profiles. In Mexico, more favorable economic profiles imply a considerably higher demographic dividend, which remains positive through 2100. This means that, *ceteris paribus*, a more favorable per capita lifecycle

**FIGURE 10 Demographic dividend (ESR) in Mexico and Spain using economic profiles from the other country**



NOTE: Solid lines indicate the changed profiles simulation; dashed lines indicate baseline scenario. See text for details. SOURCE: Authors' calculations.

deficit profile in Mexico would overcome the negative economic effects of population aging. The opposite is observed for Spain. Less favorable LCD profiles—with higher deficits and lower surpluses—than those observed in Mexico would cause the demographic dividend to become negative earlier and remain below zero longer. Hence, the same conclusion is confirmed in both cases: less (more) favorable lifecycle deficit profiles would have negative (positive) consequences for the trend in the demographic dividend, as a combination of effects in both age and education components.

### Conclusions

The potential positive effects of a favorable population age structure on economic growth have been investigated in recent decades through the estimation of the demographic dividend. This research was mainly motivated by the demographic transition that most countries are facing as they develop. Initial estimates of the demographic dividend examined the relation between the working-age population and economically dependent individuals, namely the support ratio. In the first stage of the demographic transition the working-age population grows faster than the rest of the population, producing a positive effect on economic growth. The opposite occurs in the second stage, when population aging begins and the support ratio growth becomes negative. However, the first stage of demographic tran-

sition coincided with a significant education expansion in most countries. This means that economic growth is influenced not only by changes in age structure but also by improvements in the education attainment of the population. In this article we disentangled the age and education effects through a decomposition of the demographic dividend.

We focused our analysis on Mexico and Spain, estimating their economic profiles by age and level of education. Our results reveal three key insights. First, the positive age effect in Mexico starts before 1970, peaks around 2000, and turns negative shortly after 2020. In Spain the age effect starts later, in 1980, but ends by 2020 as well. Second, the education effect is clearly higher than the age effect in the past in both countries and remains positive throughout the period observed. Adding the education component to the demographic dividend partly offsets the future negative effect of aging on the support ratio. This implies that education is an important mechanism in reducing the adverse effects of aging, as education expansion delays the start of the negative growth of the support ratio. Nevertheless, it is important to realize that higher educational attainment of the population also implies faster aging in the future,<sup>7</sup> turning the age effect more negative. Third, economic profiles by age and level of education could also have important effects on the demographic dividend. For example, our sensitivity scenarios show that if Mexico had consumption and labor income age profiles similar to those for Spain, the country could completely avoid negative growth of the support ratio. The reason is that, with more favorable economic profiles, educational expansion would be sufficient to offset a less rapid aging of Mexico's population compared to the situation in Spain.

These findings also offer insight into how to approach the demographic transition from a policy point of view. The demographic dividend could be expanded through policies that focus not only on population aging but also on expanding education attainment and increasing the lifecycle deficit surplus. This gives governments more options to overcome the potential negative impact of aging. In developing countries in the first stage of the demographic transition, education policy seems to be the best way to take advantage of, or even extend, the demographic dividend.

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## Notes

We acknowledge the institutional support from the Spanish Science and Technology System (MINECO/FEDER ECO2015-67999-R, ECO2012-35054 and CSO2013-48042-R), a Juan de la Cierva-incorporación Postdoctoral Fellowship (IJCI-2014-21178), the Catalan Government Science Network (SGR2014-1257), the XREPP – Xarxa de Referència en R+D+I in Economics and Pub-

lic Policy of the Catalan Government, the Red de excelencia SIMBIEN ECO2015-71981-REDT, the Agaur grant number FI-DGR 2013, the European Commission through the AGENTA project (grant agreement no: 613247), the UC-MEXUS/CONACYT Postdoctoral Fellowship, and the US National Institute on Aging (NIA, R37-AG025488 and NIA, R01-AG025247).

1 The dataset was constructed by the International Institute for Applied Systems Analysis at the Vienna Institute of Demography (IIASA-VID).

2 The NTA age profiles for Mexico are built upon Mejía-Guevara (2015), though estimated at the individual rather than the household level of education. Recently, NTA profiles by level of education have been obtained also for Austria (Hammer 2015).

3 Appendix is available at the supporting information tab at [wileyonlinelibrary.com/journal/pdr](http://wileyonlinelibrary.com/journal/pdr).

4 We used the newest version of the WICD data, including both past data and future projections of population distribution by educational level from 1970 to 2100 (Lutz, Butz, and KC 2014).

5 This methodology is similar to that of Mejía-Guevara (2015), except that we use individual education instead of the education

level of the household head. This approach allows us to apply the economic profiles to population projections by age and education. We assign the average level of household consumption to individuals under age 25, given that a considerable proportion of them have not finished their education. Therefore, any educational effect coming from the consumption side of the population under 25 is suppressed.

6 The GDP per effective consumer weights population by the estimated consumption profile in the corresponding country. We use the consumption profile estimated for Mexico and Spain, updated to the corresponding year.

7 Faster population aging will occur if higher education is linked to lower fertility rates. However, recent estimates from Nordic countries show a reverse trend in the negative association between educational level and fertility (Esping-Andersen and Billari 2015).

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