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Inequality in Egypt: Age-adjusted Gini coefficient

Maha Elhini¹

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Abstract

Egypt's current 'youth bulge' constitutes the majority of its population, which implies that growth in the working-age population is faster than the overall population growth rate. With a fast-growing young population in Egypt, it is important to understand whether this demographic composition has an impact on the current inequality measures, since an individual's stage in life deems detrimental for understanding his or her wealth holdings. In this light, this paper departs from the basic life-cycle impact on wealth inequality measures, and alternatively proposes an empirical method to adjust for age-effects in cross-sectional inequality for Egypt. The resulting Age-adjusted Gini coefficient (AG), eliminates wealth inequality that is attributed to age, yet it perpetuates inequality arising from other wealth-generating factors. By using wealth equalising measures, results of the Age-adjusted Gini coefficient show that age and household characteristics have no impact on wealth accumulation in Egypt, however, wealth is greatly influenced by increasing levels of education, making way for possible movement up the mobility scale.

Keywords: Gini coefficient, age, wealth, education, Egypt

JEL Classification: C10 D30 I20

1. Introduction

Wealth distribution is a prominent determinant of overall economic well-being and economic inequality. Wealth inequality remains to be a major concern for policy-makers, academics and individuals, in an attempt to garner a more egalitarian distribution, to foster social cohesion, to enhance political stability and medium-term growth. Cross country micro-level data, however, reveal substantial wealth holding variations within and between countries. Therefore, in an attempt to gauge the extent of wealth inequality, a close study of the determinants of personal wealth distribution is critical. Determinants of wealth distribution, however, ought to include attributes for which it is correct to hold a person accountable, such as education, and exclude attributes that may over/under-estimate the true inequality estimates. Age, for instance, is a determinant that is erroneously embedded in the classical inequality equation, since it is reflective of individuals' stage in life, what is known as the life-cycle impact on wealth. In this respect, inequality may exist only because individuals' wealth is compared at different stages of the life-cycle, estimating that the top quintile is wealthier because they are older and have saved more. Hence, differential wealth levels stem purely from demographic structures and are much less attributed to life-time opportunities. It is therefore essential to differentiate between wealth differences that are within age-groups from those that arise between age-groups (Almas et al. 2011).

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Theoretical and empirical literature on wealth accumulation and variation (see for example, Davies & Shorrocks, 2000) implies that the age-wealth relationship is established as essentially strong. Specifically, life-cycle-wealth relationships rise during the working life-span of an individual, and usually decline slightly when approaching retirement. This implies that wealth inequality may exist in an economy where families are completely equal in all respects except for age. Theoretically, this analysis is propelled by the standard life-cycle saving model (LCM) of Modigliani & Brumberg (1954), which explains wealth accumulation for life-cycle purposes, (Ihle & Siebert-Meyerhoff, 2017). According to LCM, individuals smooth their consumption patterns throughout their life-time to equalise discounted marginal utility. Accordingly, individuals accumulate wealth to finance expenditures after retirement. In this light, wealth is accumulated during the working-age years, and is dissaved after retirement, showing a hump-shaped age-wealth relationship. This pattern implies a larger wealth concentration at later stages in life and prior to retirement (Ihle & Siebert-Meyerhoff, 2017).

Classical inequality measures are dominated by the Lorenz curve and the related wealth Gini coefficient which was developed by the economist Max Lorenz, albeit with some degree of distortion. Embedded in its line of perfect equality, is the over-specification of the Lorenzian equality, which requires the condition of equal wealth holdings among families regardless of the age of the household head. That is, the 45-degree line implies that young households during their early stages of life are required to hold the same wealth levels as those in their retirement age, indicating a flat age amongst household heads. There are, however, valid reasons for dropping this assumption which, in itself, reflects inequity.

Furthermore, family wealth is a function of savings and time, with all families having the same saving or dissaving rate at a given stage in the life cycle. This representation would reflect equality of wealth for families within the same age bracket, allowing for differences in wealth that are based on differences in age, a principle concept which dates back to Paglin (1975), (Almas et al. (2011). This concept emphasises further that, life-cycle differences ought to be considered when measuring inequality by isolating the age effect, especially in societies where certain age groups dominate the demographic structure, such as Egypt.

Egypt's current demographic design consists of a 'youth bulge' where teenagers and young adults represent the bulk of the population structure (SYPE, 2011). Of the Egyptian population, 32 per cent are between 15 and 29 years old, 57 per cent live in rural areas where the increase in population is fastest. The overall population growth rate is 2.1 per cent, while growth in the working age population (15 to 64 years) is 2.4 per cent. Working age and youth populations are growing faster than overall population growth, especially in rural areas (Elhini and Moursi, 2015). Having that said, inequality measures may be affected by age distributions of soaring young populations. A strong age-wealth relationship coupled with the demographic structure of the economy, may be critical for reconsidering economic inequality measures. Consequently, the degree of differential wealth-holdings amongst households in Egypt, may be well explained by age differentials beside other underlying causes attributed to the propelling of economic inequality.

Wealth inequality remains to be a topic of considerable concern in changing economies such as Egypt, since inequality has been one of the main underlying drivers of the January 2011 revolution. Egypt has a society where the bulk of its households are at the peak of their age-earnings profile, hence, it is critical to approach its inequality measures more accurately. In this light, the

study departs from the basic life-cycle impact on wealth and proposes an empirical method to adjust for age-effects in cross-sectional wealth holdings for households in Egypt. The proposed method eliminates wealth inequality that is attributed to age, yet it perpetuates inequality arising from household-specific wealth-generating factors. Specifically, the study holds novel the isolation of the net age effects on inequality, while holding other determinants of wealth constant, using data from the third wave of the Egypt Labor Market Panel Survey 2012 (ELMPS 2012).

This study is organised as follows; section 2 sheds light on some highlights from the age-inequality literature. Section 3 discusses age-adjustments of the Gini coefficient and is divided into two subsections, where 3.1 describes the methodology of equalising wealth, and section 3.2 describes the data employed in the study. Section 4 displays the results of the Age-adjusted inequality (Adjusted Gini), and section 5 presents the OLS regression results.

2. Age-inequality literature

Several studies have investigated the relationship between age and inequality since (Atkinson, 1971), when he compared hypothetical wealth shares with those estimated for Britain and found that wealth within age groups is unequally distributed. Paglin (1975) was the first to derive an age-adjusted Gini coefficient that relied on a definition of wealth equality, allowing for differences in age. The so-called Paglin-Gini (PG) found that age explained a large part of inequality in the U.S. and was further developed by many authors such as Danziger et al. (1977), Johnson (1977), Kurien (1977), and Minarik (1977), (Ihle and Siebert-Meyerhoff, 2017). Oulton (1976) showed that age differences only account for 10 per cent of the observed inequality in Britain. Repetto (1978) and Lindert (1978) have determined that an ageing population is associated with a higher degree of inequality. Conversely, Morley (1981) found that a young population intensifies inequality, which was reflected in countries' demographic structures, where countries with ageing populations showed lower income inequality. Furthermore, an empirical study on Norwegian males found that average earnings rise rapidly at a young age, peak during the forties and decline slightly in the later stages of the life-cycle, (Almas et al. 2011). The cohort analysis method by Deaton and Paxson (1994), determined that income inequality increased with age in the United States, The United Kingdom and Taiwan. In Germany, more than one-third of the over-all wealth inequality was explained by age differences, with a heterogeneous impact over age groups, where no effect was evident on lower income quintiles but evidence of almost linear effects in higher income quintiles were witnessed. This effect revealed a hump shaped wealth distribution for the middle wealth quintiles, (Ihle and Siebert-Meyerhoff, 2017). Karunaratne (2000) found that income inequality in Sri Lanka first decreased then increased and finally dropped with age. While evaluating each groups Gini coefficient, it was determined that increased inequality was caused by age effects, (Zhiqiang et al. 2018). Additionally, income in Asian countries was found to increase with age, much of which was caused by population ageing, (Ohtake and Saito 1998). Moreover, Kang (2009) found that in South Korea a strong positive linear relationship between ageing and income inequality was witnessed after the age of thirty-five. A further study on China by Qu and Zhao (2008), examined factors determining income inequality in rural areas and found that income inequality increased with age by a small age effect (Zhiqiang Dong & Wei, 2018). A study on the impact of the age structure on household wealth inequality in U.K., Italy, Finland, Sweden, and the U.S. found minor age impacts of wealth differentials between households (Ihle and Siebert-Meyerhoff, 2017). Furthermore, Zhong (2011) and Zhou and Li (2009) found that a significant

part of the increase in income inequality was attributed to demographic change and age in different cohorts. Furthermore, a theoretical model by (Zhiqiang Dong & Wei, 2018) indicated that population aging intensified income inequality in the Chinese economy.

3. Age-adjustment of the Gini coefficient

The classical Gini coefficient (G), is used to measure inequality. The Gini coefficient, however, is not a flawless measure. According to Paglin (1975), G overestimates equality owing to a flat age-earnings profile. Almas et. al (2011), propose that a significant fraction of overall inequality is attributed to inequality between age groups, confusing older as richer. Therefore, the Gini coefficient is seen to incorporate much of the cross-sectional inequality that may be smoothed out over the life-cycle. Hence, age adjustments for cross-sectional measures of inequality are seen to present more accurate measures.

3.1 Methodology: Equalising wealth

The Lorenzian Gini coefficient assumes that the equalising wealth is the population mean wealth. This assumption entails that, first, for individuals to achieve perfect equality, they should all have equal lifetime wealth and second, that individuals of all ages must have the same wealth holdings in any given year. According to Almas (2011), measuring inequality while adjusting for age, (AG), defines the equalising wealth not as the society's mean wealth but as a function of each age group, excluding all other wealth-generating factors. By that, AG allows equalising wealth to depend on the age of individuals disposing it from the classical inter-age life-cycle component. Hence, age-adjusted Lorenz curves are ordered not in terms of wealth of individuals per se, but in terms of the difference between actual and equalising wealth. Therefore, G and AG range over different intervals, where G reaches a maximum of 1 when hypothetically one individual holds all wealth in the society, in contrast, AG takes a maximum value of 2 when the equalising wealth of the individual who owns all wealth is zero. The equalising wealth is the same for all individuals within the same age group and is a function of this group's age only. Similarly, the equalising wealth of one of the individuals with no wealth is equal to the aggregate wealth in the economy. Thus, G and AG range over different intervals according to their different views of equalising wealth (Almas et. al 2011).

Further inequality measures distinguish between AG and Wertz Gini (WG), the latter measure considering the equalising wealth as the unconditional mean wealth level in every age group whereas the former measure defines equalising wealth as the net age effect of belonging to this group, after removing other wealth generating factors that may be correlated with age. Hence, differences between AG and WG are the result of omitted variables bias.

Paglin-Gini, (PG), aggregates differences in actual and equalising wealth and is based on a comparison between differences in the absolute values of actual and equalising wealth levels between all pairs of individuals. PG will differ from WG if there is any age impact on wealth, given that there is some within-age-group variation (Almas et. al 2011). Details on the relation between AG, G, PG and WG are given in the appendix and are attributed to Almas et. al, (2012).

This study's empirical analysis utilizes the above three age-adjusted inequality measures. The study aims at relaxing the conventional Gini coefficient assumption of flat age-earnings profile following Almas et. al, (2012). First, the new age-adjusted Gini coefficient (AG) is dis-

cussed, followed by the classical Gini coefficient (G), later by Paglin's Gini (PG) and Wertz' Gini (WG) respectively. The measure is applied to cross-sectional data for Egypt. To the author's knowledge, this is the first study that calculates an age-adjusted Gini coefficient for Egypt. The study deems important owing to the country's growing youth population, a phenomenon that may steer questions on the impact of this demographic shift on inequality measures.

4. Data description

The current study uses data from the third wave of the Egypt Labor Market Panel Survey 2012 (ELMPS 2012). The survey presents extensive demographic and socio-economic data on both the individual and household levels. The micro data underlying the ELMPS 2012 is jointly conducted and made publicly available by the Economic Research Forum (ERF) and the Central Agency for Public Mobilization and Statistics (CAPMAS). The survey presents extensive demographic and socio-economic data on both the individual and household levels capturing characteristics such as household composition, education, housing, services utilized, migration, remittances, labor market and human resource development in Egypt, (Assaad & Krafft, 2013). ELMPS 2012 is stratified over six regions and multi-level stratified into sub-groups. The ELMPS 2012 design uses cluster sampling where units are represented by households rather than individuals. The survey includes 49,186 individuals who belong to 12,060 households, representing 80.1 million individuals and 19.6 million households. The sample is adjusted by using household weights to ensure national representation of the results.

A household wealth index is computed using the survey data on assets ownership. The wealth index is based on both household durable and non-durable assets as a proxy of long-term wealth. First, an estimated wealth or (assets) index is calculated from the ELMPS 2012 household assets survey to include a set of assets in the form of binary variables that reflect household living standards and housing characteristics, hence called "asset indicators" or "asset variables", that construct an "asset or wealth index" (Filmer & Pritchett, 2001). Housing characteristics include type of dwelling, number of rooms per dwelling, number of persons per room, quality of housing material (type of floor material, type of wall material), type of sewerage, electricity, type of drinking water, refrigerator, washing machine, iron, type of TV, radio, internet, bike, type of transportation, etc. Assets and infrastructure used in calculating the wealth index include land ownership versus rent and house ownership versus rent. The wealth index is calculated by a selection of weighted indicators of household assets using the principal components factor analysis (PCFA), which is a method for extracting from the given set of asset variables, the few orthogonal linear combinations of the variables, capturing common information in the best possible way in order to determine weights for the index of asset variables (Filmer & Pritchett, 2001).

In this study the household is represented by the household head and is used as the economic unit, since assets are calculated at the household level following past studies on wealth distributions. Household head age is divided over age groups relying on past studies in the inequality literature such as Almas *et al.* (2012). Accordingly, household heads are divided into seven age groups — less than 24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, 65-74 years

and above 75 years old¹. The sample consists of 12,060 household heads with an average age of approximately 46 years old, a minimum age of 16 years and a maximum age of 100 years old.

Education is categorized into seven groups – illiterate, read and write, less than intermediate level of education (less than preparatory), intermediate level of education (preparatory), above intermediate level of education (secondary), university level and post-graduate. Furthermore, control variables are included in the study to include sex, where male is indicated by 1 and female by 0. Household size is defined as the number of individuals per household. Regional controls included in the study are shown across an urban-rural divide, using one of the country's two regional categories, Upper and Lower Egypt, in which urban governorates are indicated by 1, and rural governorates indicated by 0.

5. Results of Age-adjusted inequality (AG)

Age-adjusted inequality results for Egypt are shown in table 1 below, and reveal relatively low wealth inequality measures, conforming to the income inequality index calculated by the World Bank. Usually, however, the wealth Gini is higher than the income Gini. Similarly, the study finds a slightly higher wealth Gini measure (G), relative to the income Gini of 0.32 in 2012 (World Bank estimate 2012). The study accounts for various age-adjusting inequality scenarios, first, by accounting for age only without taking into consideration family background controls, and secondly, accounting for household characteristics. Results show no discrepancy between both scenarios, where AG is equal to 38 per cent in both scenarios, indicating that family background characteristics have no impact on age adjustments of inequality.

Furthermore, G is equal to AG indicating that accounting for age in the inequality measure has no impact on the level of wealth distribution. G_b at 8 per cent, reflects the population share in the weighted-average of the different age-groups. This means that G_b increases with differences in mean earnings across age groups as well as with the number of individuals in each age group. G_b over age groups may explain why PG slightly differs from G . Also, the disparity between G and PG may be due to the share of the population in each age group, where the majority of the population are concentrated between ages 25 and 54. WG will differ greatly from PG when there are age effects on wealth and when within group wealth variations show minor differences, but results show no age impact on wealth distribution. WG and AG may differ in general due to omitted variables bias. However, their equal measures in the study show that the results reflect no traces of omitted variables bias while controlling for family background characteristics.

Table 1. Age-adjusted Gini Coefficient

Gini (G):	0.38
Between-Gini (G_b):	0.07
Paglin (P):	0.31
Wertz (W):	0.38
AG:	0.38

¹ The theoretical background of the choice of age groups widths on adjustments of inequality are discussed by Formby *et al.* (1989) and Paglin (1989).

6. OLS Regression results

A multivariate regression model is employed to estimate the impact of age on household wealth, where the set of control variables used are sex, educational attainment indicated by level of schooling attained, household size and region of residence. Results are shown in table 2 below, revealing a significant but weak positive correlation between *age* and wealth for the age groups 25 to 34, 35 to 44 and 45 to 54. Table 2 shows insignificant results for individuals below 24 years, individuals between 55-64 and between 64-74.

Table 2. Estimation results of age-wealth regression

	Coefficient						
Age Range	< 24	25-34	35-44	45-54	55-64	65-74	>75
Age	0.02 (0.38)	0.02*** (0.00)	0.02*** (0.00)	0.02*** (0.00)	0.00 (0.64)	-0.01 (0.53)	-0.01 (0.15)
Education							
Reads & Writes	-0.12 (0.64)	0.36*** (0.00)	0.35*** (0.00)	0.42*** (0.00)	0.38*** (0.00)	0.54*** (0.00)	0.50*** (0.00)
Less than Intermediate	0.36*** (0.01)	0.34*** (0.00)	0.47*** (0.00)	0.45*** (0.00)	0.51*** (0.00)	0.69*** (0.00)	0.77*** (0.00)
Intermediate	0.57*** (0.00)	0.57*** (0.00)	0.65*** (0.00)	0.76*** (0.00)	0.90*** (0.00)	1.02*** (0.00)	1.29*** (0.00)
Above Intermediate	1.02*** (0.00)	0.99*** (0.00)	0.91*** (0.00)	1.02*** (0.00)	1.22*** (0.00)	1.01*** (0.00)	0.97*** (0.01)
University	1.17*** (0.00)	1.08*** (0.00)	1.17*** (0.00)	1.26*** (0.00)	1.45*** (0.00)	1.57*** (0.00)	1.57*** (0.00)
Post-Graduate		1.38*** (0.00)	1.45*** (0.00)	1.36*** (0.00)	1.80*** (0.00)	1.98*** (0.00)	2.14*** (0.00)
Urban	0.59*** (0.00)	0.63*** (0.00)	0.69*** (0.00)	0.71*** (0.00)	0.78*** (0.00)	0.87*** (0.00)	1.03*** (0.00)
Sex	-0.05 (0.57)	-0.03 (0.54)	0.01 (0.86)	0.00 (0.97)	-0.13*** (0.00)	-0.10** (0.05)	-0.14* (0.08)
hhsiz	-0.20*** (0.00)	-0.14*** (0.00)	-0.12*** (0.00)	-0.08*** (0.00)	-0.07*** (0.00)	-0.03*** (0.01)	0.03* (0.06)
Constant	-0.60 (0.27)	-0.81*** (0.00)	-0.86*** (0.00)	-1.28*** (0.00)	-0.51 (0.15)	-0.28 (0.65)	-0.11 (0.87)
R ²	29%	37%	45%	48%	54%	55%	51%
N	444	3167	2571	2196	1964	1131	584
<i>P values in parentheses, *** 0.01, ** 0.05, * 0.1</i>							

The correlation between wealth and education, shows that individuals who are below 24 years old, who only read and write, show insignificant results. Older age groups of the same educational category show a weak positive correlation with wealth. Individuals who have less than intermediate education have a relatively stronger correlation with wealth than their less educated peers. Individuals with intermediate education have a highly significant and relatively stronger correlation with wealth than individuals on a lower educational scale, showing a correlation that gets stronger with older age groups. Others with above than intermediate education and university level education, have a stronger correlation with wealth relative to individuals

with lower levels. Results show further that individuals with post graduate education have the highest correlation with wealth.

The variable *sex* is not significant in the wealth model for all age groups. The regional variable *urban* is negatively correlated with wealth in favour of rural residents. Household size is negatively correlated with wealth and the correlation weakens as individuals get older.

Figure 1. Wealth distribution by education

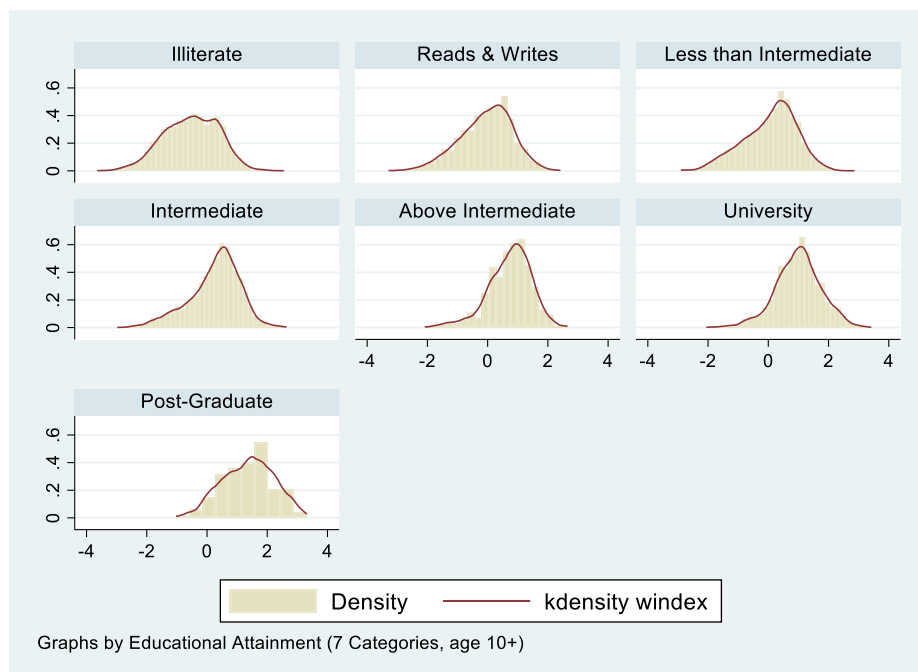
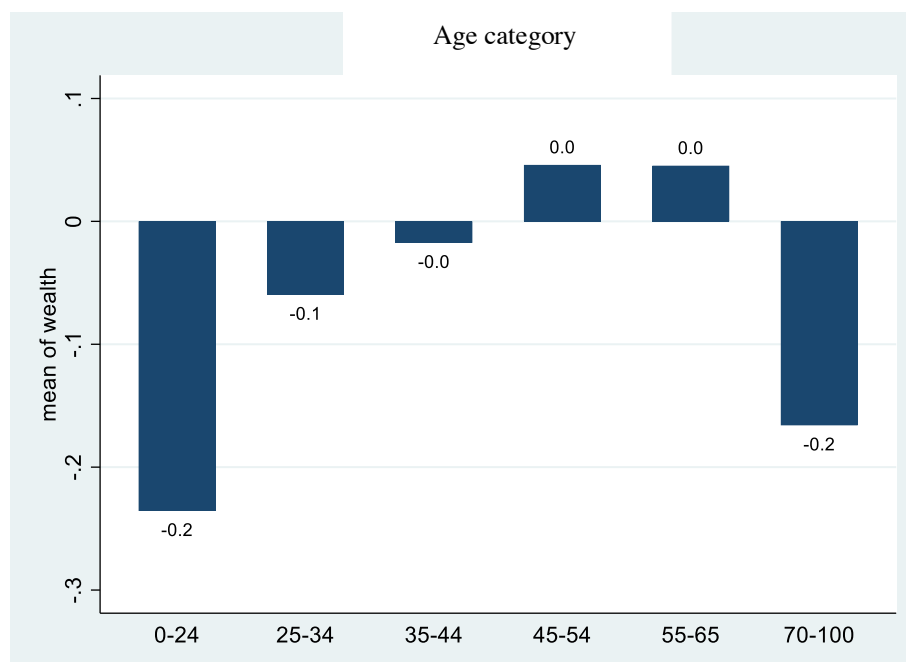


Figure 2. Average wealth distribution by age



The overall results support a high correlation between wealth and education for Egypt, where wealth is correlated with higher levels of education and not with age. Regression results in Table 2, are in line with results in Table 1, indicating that accounting for age in the inequality measures for Egypt has no impact on the level of wealth distribution. Education, therefore, plays an important role in determining wealth inequality in Egypt, providing opportunities for educational mobility.

Figure 1 shows the distribution of wealth by the level of education. The graphs indicate that individuals with lower educational levels are more skewed towards negative wealth holdings, the intensity of which is reduced as levels of education increase. Postgraduates show relatively low negative wealth holdings and a distribution towards the positive end.

Figure 2 below, shows a wealth distribution for Egypt that conforms to the hump-shaped life-cycle, albeit on a much lower scale. The age-wealth profile increases (from negative to positive) until mid-age and decreases after retirement. Wealth is not positive at any age level except for the age range 45-65, after which it falls dramatically.

Egypt, being a lower-middle income country where wages are relatively low, wealth accumulation is fairly difficult on the household level. Furthermore, parents' support for their children from birth until they get married and leave home, puts a heavy burden on household expenditure. Having that said, as parents get older, their savings show a negative drop as indicated by the graph.

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Appendix

The following relies on (Almas et. al, 2012).

The joint cross-sectional distribution Y of actual and equalising wealth is defined as:

$$Y = [(w_1, \tilde{w}_1), (w_2, \tilde{w}_2), \dots, (w_n, \tilde{w}_n)]$$

Let Ξ denote all possible joint distributions of actual and equalising wealth such that the sum of actual wealth equals the sum of equalising wealth. Suppose the following modified versions of the standard conditions on an inequality-partial ordering defined on the alternatives in Ξ are imposed, where $A \preceq B$ represents that there is at least as much age-adjusted inequality in B as in A . Let μ denote the mean wealth of the population as a whole. Let the distributions of differences (Δ_i 's) between actual wealth w_i , and equalizing wealth \tilde{w}_i for the two distributions [$\Delta_i(A) = w_i(A) - \tilde{w}_i(A)$ and $\Delta_i(B) = w_i(B) - \tilde{w}_i(B)$] be sorted in ascending order such that $\Delta_i \leq \Delta_{i+1}$.

Condition 1. *Scale Invariance*: For any $a > 0$ and $A, B \in \Xi$, if $A = aB$, then $A \sim B$.

Condition 2. *Anonymity*: For any permutation function $\rho: n \rightarrow n$ and for $A, B \in \Xi$, if $\{w_i(A), \tilde{w}_i(A)\} = \{w_{\rho(i)}(B), \tilde{w}_{\rho(i)}(B)\}$ for all $i \in n$, then $A \sim B$.

Condition 3. *Unequalism*: For any $A, B \in \Xi$ such that $\mu(A) = \mu(B)$, if $\Delta_i(A) = \Delta_i(B)$ for every $i \in n$, then $A \sim B$.

Condition 4. *Generalized Pigou–Dalton*: For any $A, B \in \Xi$, if there exist two individuals s and k such that $\Delta_s(A) < \Delta_s(B) \leq \Delta_k(B) < \Delta_k(A)$, $\Delta_i(A) = \Delta_i(B)$ for all $i \neq s, k$, and $\Delta_s(B) - \Delta_s(A) = \Delta_k(A) - \Delta_k(B)$, then $A \succ B$ (Almas et. al., 2012).

The generalized Gini formula is based on a comparison of the absolute values of the differences in actual and equalizing wealth between all pairs of individuals. It is defined as follows:

$$AG(Y) = \frac{\sum_j \sum_i |(w_i - \tilde{w}_i) - (w_j - \tilde{w}_j)|}{2\mu n^2} \quad (1)$$

The AG index satisfies conditions 1–4. These conditions are similar to those underlying G in all respects but one: the equalizing wealth is not given by the mean wealth in the society as a whole but instead depends on the age of the individuals.

The wealth level of individual i depends on his or her age group and on i 's lifetime resources given as a function h of a vector X of individual characteristics. The function is defined as:

$$w_i = f(a_i) h(X_i) \quad (2)$$

According to Almas et. al, 2012, the above functional form depends on the underlying model of wealth accumulation, in which the life-cycle model has no uncertainty. That is, individuals earn a constant income until retirement age, and the interest rate, as well as the rate of time preference, is zero. In the life cycle model, the wealth of an individual increases until retirement and decreases afterward.

Empirically, Almas et. al, 2012 specify the functional form of f , yielding the wealth-generating function:

$$\ln w_i = \ln f(a_i) + \ln h(X_i) = \delta_i + X_i B, \quad (3)$$

Equalizing the wealth level of individual i depends on his age as well as on all other wealth-generating factors of individuals in the society, and it is defined as:

$$\tilde{w}_i = \frac{\mu n \sum_j f(aj)h(x_j)}{\sum_k \sum_j f(ak)h(x_j)} \frac{\mu n e^{\delta i}}{\sum_k e^{\delta k}} \quad (4)$$

where $e^{\delta k}$ gives the net age effect of belonging to age group k after removing influence of other wealth-generating factors correlated with age. If there is n age effect on wealth, the equalizing wealth level is equal to the men wealth level in the society (Almas et. al, 2012).

The Gini coefficient G is defined as:

$$G(Y) = \frac{\sum_j \sum_i |(w_i - \mu) - (w_j - \mu)|}{2\mu n^2} \quad (5)$$

There are two different age-adjusted inequality measures are considered in this paper that have the same objective of relaxing the assumption of a flat age-wealth profile as AG . Namely, Paglin Gini PG , and Wertz-Gini, WG are assessed below using the previous conditions 1-4 and their relation to AG .

First, WG is considered that was proposed by Wertz (1979) as a correction for PG . Wertz defined WG as:

$$WG(Y) = \frac{\sum_j \sum_i |(w_i - \mu_i) - (w_j - \mu_j)|}{2\mu n^2} \quad (6)$$

where μ_i and μ_j indicate the mean wealth level of all individuals belonging to the age group of individuals i and j , respectively. Like the AG index, WG is based on a comparison of the absolute values of the differences in actual and equalizing wealth levels between all pairs of individuals and ranges over the interval $[0, 2]$. It also satisfies conditions 1–4. However, WG defines the equalizing wealth of an individual i as the unconditional mean wealth levels in i 's age group, μ_i , and will therefore eliminate not only wealth inequality due to age but also differences due to wealth-generating factors correlated with age, such as education. The standard omitted-variables-bias formula proposes that WG will be equal to AG whenever age is uncorrelated with omitted wealth-generating factors. Hence, AG may be viewed as a generalization of WG , in situations where omitted variables bias is a major concern.

Secondly, PG is expressed as:

$$PG(Y) = \frac{\sum_j \sum_i |(w_i - w_j)| - |(\mu_i - \mu_j)|}{2\mu n^2} \quad (7)$$

where μ_i and μ_j indicate the mean wealth level of all individuals belonging to the age group of individuals i and j , respectively. Applying the standard Gini decomposition, we can rewrite PG as

$$PG = G - G_b = \theta_i G_i + R \quad (8)$$

where G_b represents the Gini coefficient that would be obtained if the earnings of each individual in every age group were replaced by the relevant age group mean μ_i ; G_i is the Gini coefficient of earnings within the age group of individual i ; θ_i is the weight given by the product of this group's earnings share $n_i \mu_i / \mu n$ and population share n_i / n (n_i being the number of individuals in the age group of individual i); and R captures the degree of overlap in the earnings distribu-

tions across age groups (n_i being the number of individuals in the age group of individual i); and R captures the degree of overlap in the earnings distributions across age groups (Almas *et al.* 2012). According to Lambert and Aronson (1993), the overlap implies that the wealth holding of the richest person in an age group with a relatively low mean wealth level exceeds the wealth holding of the poorest person in an age group with a higher mean wealth level; that is, $w_i < w_j$ and $\mu_i > \mu_j$ for at least one pair of individuals i and j . Also as stated in proposition 1 in Almas and Mogstad (2012), PG will differ from WG if there is any age effect on wealth, provided that there is some within-age-group wealth variation. Moreover, overlap in the wealth distributions across age groups, that is, $R > 0$, is a sufficient condition for $WG > PG$. A corollary is therefore that PG is likely to yield a different ranking than WG in situations where countries differ substantially in the degree of overlap. As with the case of WG , PG also defines the equalizing wealth of an individual i as the unconditional mean wealth level in i 's age group, $\bar{\mu}_i$ disregarding that other wealth-generating factors are correlated with age (Almas *et al.* 2012).

Moreover, PG is based on a comparison of differences in the absolute values of actual and equalizing wealth levels between all pairs of individuals, $\left| |w_i - w_j| - |\mu_i - \mu_j| \right|$. This violates the unequalism condition because $\left| |w_i - w_j| - |\mu_i - \mu_j| \right| = 0$ does not necessarily imply that $\left| (w_i - \mu_i) - (w_j - \mu_j) \right| = 0$. Almas and Mogstad (2012), indicate that because $\left| (w_i - w_j) - (\mu_i - \mu_j) \right|$ provides an upper bound for $\left| |w_i - w_j| - |\mu_i - \mu_j| \right|$, it follows that $WG \geq PG$. Therefore, PG will differ from WG if there is any age effect on wealth, provided that there is some within-age-group wealth variation (Almas *et al.* 2012).