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IMPORTANT ISSUES IN POPULATION STUDIES

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***Abstract:** Population studies in financial area have been strongly influenced by life cycle hypothesis purported in Economics by Modigliani and Blumberg (1956). There is an extensive literature review on recent studies in this area. However, there seems to be a lack of consensus regarding the importance of population studies and methodologies used in financial industries, in particular. The inputs are rather inaccurate or highly smoothed at best, which could have a downward impact on true correlation and volatility values. Countries apply different census dates, for instance once in a decade, and all changes in between two census dates are updated in accordance with projections that are regularly inaccurate. With an increase in labor force cross-border movements, and the number of localised conflicts population estimates are most likely to become even more inaccurate than is currently the case. Another crucial issue is rather politically motivated; the ageing Western societies may not have booming economies that are capable of absorbing foreign workforce at ever increasing rates, but they still require a fresh influx of labour force for either low-paid or specific jobs that are generally shunned by respective local populations. In addition to these complexities, a major constraint still remains in the area of model evaluations. Regression variables are expected to be stationary. Nevertheless, in the area of population studies in Finance some population variables may not be stationary, the periods for analysed age cohorts are arbitrarily determined and results are difficult to generalise due to these constraints.*

***Key words:** population study, census, financial markets.*

1. Introduction

In modern nations the determination of population trends has always been an important issue. It provides the workforce for the growing economy, supports the socio-political development in an environment that is not necessarily supportive for international cooperation and determines the ability of the state to react to external threats. With an increase in cross-border movements of workforce, not only in the EU, but also internationally, there are additional analyses of the composition of respective populations. While the richness of international experiences allows for a more dynamic exchange of

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UDC 314

experiences and goods within boundaries with an increase in localised conflicts since the end of WWII, there is an increasing concern about the forms and effectiveness of naturalisation policies vis-à-vis populations segments that may not share similar values. Politicians pursue short-term goals in an attempt to align personal with national and supranational interests, which depends on their posts in host countries or abroad. In such an environment, it is politically opportune to neglect medium to long-term issues, and relegate them to occasional expert studies or forecasts provided by specialised government agencies. The findings are rooted in scientific projections and scenario analyses, but the lack of public debate or the occasional trivialisations of important findings by political factions with daily and populist agenda for a median voter indicate that the further neglect of this issue is rather costly. Combined with a probable climate change, a lack of arable land and resources, the cross-border population movements will pose further challenges for international community. While developed nations have capabilities to dampen the impact of climate changes for a longer period of time, in developing economies a marginal increase in the costs of staple food leads to further destabilisation.

The recent string of studies on the impact of the baby boom generation in the US on returns in stock and markets reflects the fact that corrections to the pension funding schemes have already been contemplated or initiated, not only in the US, with respect to the potential impact of the aging population. Figures 1 and 2 show that in selected developed countries the ratio of retirement-age population has steadily increased since the 50s. It is also evident that over the last three decades there is an increase in the later-years working population (40-64 years) as opposed to younger workers (20-39 years). Following the end of World War II the US doubled the industrial output vis-à-vis the pre-war period and a drive to help rebuild the economies, primarily in Western Europe, was conducive to the assertion of the US as a global power. An increase in birth rates was the consequence of these economic growth rates that are generally seen in times of unexpected interruptions in human development. Another impetus for excessive economic growth since the end of WWII was the drive for globalisation and deregulation in the 80s, followed by a demise of the so-called communist world at the beginning of the 90s. Even if sweeping political changes did not reach all countries with similar force, the changes in the economic environment were rather unambiguous. To rebuild a country on new entrepreneurial foundations or to risk being exposed to another period of isolation, the consequences of which were quite evident throughout 20th century, were options faced by some Asian countries.

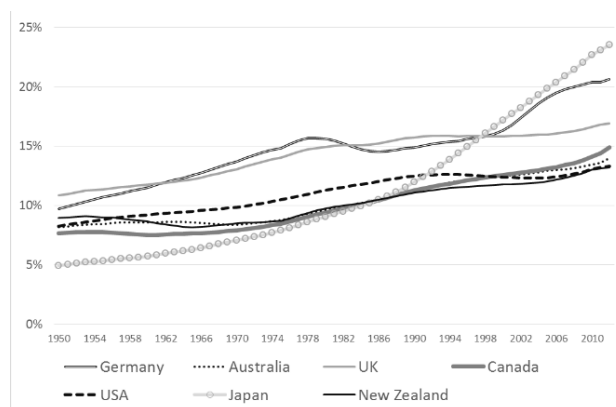


Figure 1: Ratio of 65+ to Total Population

Important Issues in Population Studies

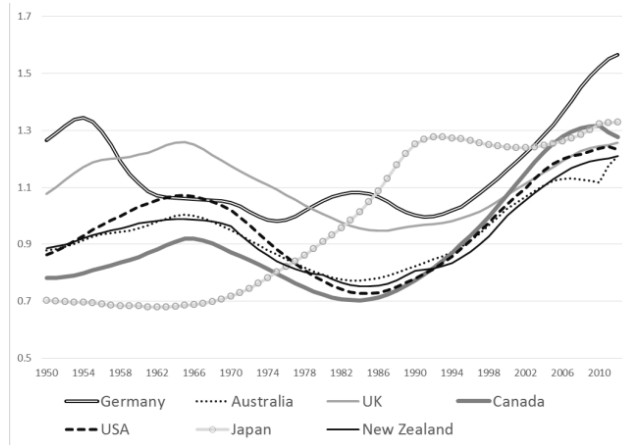


Figure 2: Ratio of Aged 40-64 vs. Aged 20-39

Studies preceding the paper written by Davis and Li (2003) mainly referred to demographic variables and linked them to effects on returns in stock markets and bonds. Based on findings and suggestions outlined in this and some other seminal papers such as those published by Poterba (2001 and 2004) there were multiple attempts to compare various countries and variables in order to examine if there is a relationship with population variables. However, countries were either analysed to confirm or refute the claims about a single country in a study or they were observed together in an attempt to find lasting policy messages. However, there are no distinctive attempts to compare population trends *and* evaluate individual countries' specifics in a single study. In addition, the applied methodologies face important constraints, because real census data are obtained once in a decade, sometimes even more irregularly, and data used in respective studies are annual or quarterly estimates. Data may not be variance-covariance stationary, which is an essential request for regression analysis or the selection of age cohorts is arbitrary. In this study we address general population issues by reviewing interdisciplinary studies. We shall also address the links between financial institutions and aging populations and finally examine challenges researcher face in population studies.

2. The Importance of Population Studies

Migrations allowed human beings to conquer the most remote and least hospitable corners of the world. Movements were either voluntary or forced through wars, natural calamities and pestilence. With the creation of modern states the significance of recording the number of citizens and the composition of the same became important. Inevitably, some countries with booming economies have an influx of population, while others are burdened with a loss of population. However, it is generally ignored that even among traditional immigration countries there could be differences and even a brain drain. For instance, US, Canada, Australia and New Zealand are historically prominent immigration countries. Immigration policies have different impact on the number of immigrants (calculated as the ratio to the total population) in respective countries. While US and Canada, as part of NAFTA and NATO pact maintain strong links to Europe and Central and South America,

Australia and New Zealand in spite of their dominant European heritage are increasingly linked to the Pacific Rim and Asia, in particular. Finally, New Zealand has faced a population loss to Australia, even though there was a net gain in population over the last several decades (Bedford *et al.*, 2010). Personal disposable income in New Zealand represents only 52% of that in Australia and it seems to be a strong reason for emigration to the Commonwealth of Australia (EIU Viewswire, 2010).

UK is an immigration country not only for non-EU nations, but also for recently acceded EU member countries from Central and Eastern Europe (Matheson, 2010, p. 25 and Ellis, 2009). Immigration is expected to supplement below-replacement fertility rates and support economic growth. Therefore, some countries like Canada apply numerical targets and selection criteria for new immigrants (Foot, 1996). Immigrants can be selected for employment posts that are not chosen on sufficient numbers by applicants in a specific country. However, the offspring or even the same immigrants who decide to upgrade skills will start seeking jobs that are in demand by domestic population. The baby boomers in the US have profited from a strong economic growth following the end of WWII and a globalisation drive at the end of the last century. The competition for jobs was mainly intragenerational, but the smaller baby bust generation in seeking and retaining jobs faces the competition within the same cohort, with respect to baby boomers, and finally, declining economic growth rates. In order to become more responsive companies apply flatter hierarchical structures, which leads to slower promotions (Venne, 2001). At the same time more qualified graduates join the workforce in an expectation to fulfil fewer management positions. Therefore, horizontal movements among companies replace vertical movements and employees are not employed for a longer period of time in the same firm. This trend has started in the baby boom generation and is expected to continue (US Bureau of Labour Statistics, 2012). The entire process is further aggravated by the outsourcing strategies of US companies and estimates that one out of five employees is not proficient on the jobs. The US employees not only compete with immigrants, but also with global job markets (Heenan, 1985).

Poterba (1997) shows that an increase in elderly population in the US leads to a decrease in per-child educational spending, and the impact gets stronger if there is a racial difference between elderly residents and school populations. The reduction of per-child educational spending coupled with slower economic growth rates would further undermine the competitiveness of the US economy. By contrast, older voters could be prompted to invest in younger workers, which would increase contribution to elderly population in the future. Altruism and a change in the prices of real estate could be another factor reducing intergenerational conflicts. Better schools would attract better quality tenants and homeowners, and the prices of all properties in the region could be positively affected. Finally, the Tiebout sorting allows for elderly population to move to communities where tax payments for public schooling are lower and leave communities with higher taxation rates (Poterba, 1998). When the impact of the elderly population is analysed for two cohorts (65-74 and 75-over years) it is apparent that the contribution to schooling declines more as the population gets older. In addition, the in-migration of older population reduces spending on public schools, while out-migration has a positive effect (Tosun *et al.*, 2009)

3. Population and Financial Markets

The founding idea on the relationship among generational cohorts and financial markets originated in the life cycle hypothesis purported by Modigliani and Brumberg (1954). The younger generation uses salary income to acquire real estates, while older generations increase savings and invest in financial assets, which could affect real estate and financial asset prices to varying degrees and at different timeframes. The postulates of this theory coincide with the emergence of the Baby Boom generation that includes 79.6 million individuals born in the US between 1946 and 1965. An increase in births followed recession years and World War II and was subsequently curbed by an increase in the use of contraceptives and other forms of birth control in mid-60s. The decline in fertility rate and an increase in the average population age has since become a global process, which prompted researchers to focus on projections by mid- and end of this century. Bongaarts (2009) claims that the developing world's fertility rate of more than six children per female in the 60s will have declined to fewer than two by mid-century, except for Africa where this ratio would still be above 2. These trends lead to the creation of population 'columns' with a subsequent conversion to inverted pyramids if fertility supporting policies fail to materialise. In a study for the UK it is claimed that a gradual increase in retirement age to 68.5 in 2050 and 70.2 in 2070 will keep the ratio of people over state-pension age (SPA+) to 20-SPA cohort relatively stable (Turner, 2009). An increase in contribution rates would delay the introduction of preferred retirement age (Lacomba and Lagos, 2006). However, the major threat is still imposed by declining fertility rates and inability of future working generations to absorb without a large illiquidity discount an overhang of assets managed on behalf of retirement age population. This problem is further aggravated by a transition from pay-as-you-go pension schemes and the expansion of state-owned reserve/sovereign funds.¹

One of the first articles that linked the value of assets to population factors examined the impact on housing prices. The US citizens in the cohort between 20 and 35 years exert the strongest impact on the value of housing pricing, which coincides with the baby boom cohort entering the real estate market in the 80s (Mankiew and Weil, 1989). Thereafter, researchers paid attention to the relationship between population and public stock markets. Using the Euler equation Bakshi and Chen (1994) show that aggregate consumption and demographic fluctuations could forecast risk premia. As the population ages more wealth is transferred to stock markets rather than housing markets. An average-age increase influences political risk ratings, while demographic factors can forecast long-term returns internationally (Claude, Campbell and Viskanta, 1997).

By contrast, Poterba (2001) does not find evidence that demographic cohorts have relationship with Treasury bills, long-term government bonds and stock returns. Moreover, there is no abrupt decline in the asset demand over the period 2020 – 2050 (Poterba, 2004). The author does confirm that results are strongly influenced by the choice of econometric specifications. Davis and Li (2003) examine the relationship between demographic indicators and financial asset prices in selected OECD countries. Real asset returns are supported by the cohort with a population aged between 40 and 64. The cohort comprising people aged 65 and over drives stock prices down and supports an increase in bond yields,

¹Brooks (2002) shows that the retired baby boom generation will live better than parents and children and rejects the idea that these retirees should not support the current transition from defined-benefit to defined-contribution schemes.

which is contrary to Poterba's forecasts and purports the view about depressed asset prices. The inclusion of a bequest in intergenerational transfers reduces the consumption of older generations and mitigates the meltdown of asset prices (Abel, 2001). Geanakoplos et al. (2004) find that equity prices are in phase with demographic changes, and attain maximum when the number of young agents is minimised. However, rates of return do not follow the demographic changes. Goyal (2004) extends the overlapping generations model (OLG) to four generations: Infants, Youth, Middles and Olds and proves that as the ratio of the middle-aged cohort increases the aggregate wealth becomes larger. In empirical tests, the outflow from stock markets is positively associated with changes in the age cohort of people older than 65 years, while it is negatively correlated with the middle-aged cohort (45 – 65 years). The inclusion of the capital as a variable depending on the demographic factors allows for a direct relationship between age-structure and financial markets (Brunetti and Torricelli, 2008). Brawn and Sevic (2013) examine selected developed economies using annual and quarterly dataset and find that Japan and to a certain extent Germany have a different impact of age cohorts on yields in bond markets. It is believed that differences originate in specificities of bank-based economies, as opposed to the rest of the sample dominated by market-based economies. It is also confirmed that the US quantitative easing has had a lasting impact on yields.

4. Challenges in Conducting Population Studies

Demographic data for cross-country analyses could be primarily sourced from the United Nations Statistics Division (UNSD) or UN database of annual population estimates (from 1950 to data). If data/forecasts are not sufficiently covered, national statistics offices provide additional information. For instance, in Germany *de Statist* produces annual estimates and projections by age and gender from 2009-2060; however, there has been only one population census since unification in 1990². In spite of the infrequency of census surveys, population estimates are based on monthly births, deaths and migration data, complimented by additional labour market surveys. In the UK, the *Office for National Statistics* (ONS) Demographic Analysis Unit provides intercensal population estimates by age, gender and region with projections from 1992-2033, as well as annual data from 1971-2011 by quinary age groups³. United States and Japan statistical offices provide rather long historical data, available from 1900 and 1920 to the present respectively, and both include separate estimates for males, females and in the case of US, even by single-year age cohorts. The US Department of Commerce: Census Bureau produces monthly population estimates by gender and age.

Population trends are estimated without the inclusion of factors that slow down or accelerate changes in population growth rates such as geophysical impacts, climatic changes, biological outbreaks of pandemics or social collapses, such as wars (Jones, 2003) and the examination of future trends by neglecting to evaluate historical ones leads to over-

² Source: www.destatis.de The most recent German census took place on May 9, 2011. Prior to this date the last full population census in the former West Germany was conducted in 1987, whereas the last census taken in what was East Germany occurred in 1981. The first ever German census was taken in 1871.

³ Quinary or 5-year age cohorts are the norm, typically starting with the 0-4 age group, then 5-9, 10-14 etc.

Important Issues in Population Studies

or underestimates. This is being confirmed when projections are compared against occasional census data. Thayer (2009) includes great power war, small power war, civil war and terrorism as important social factors that could change global and European population trends. It could be postulated that the imperial wars of the 19th and early 20th century, complemented or followed by secessionist wars leading to the creation of nation-states would be replaced by an international world of co-operation and peaceful resolution of conflicts. Wimmer and Min (2006) find that in the years following the creation of nation-states the interstate wars and non-secessionist civil wars do not quickly subside as expected. Wars are militarily opportunistic in states of anarchy or dysfunctional countries and the evaluation of geographical boundaries combined with population densities provides fairly good approximations for war casualties (Wesley, 1962). In civil conflicts it is necessary for an ethnic majority to face a large minority (Horowitz, 1985). Homogenous societies and countries with smaller ethnic minorities do not face civil war threats as frequently, which implies that ethnic fractionalisation does not properly account for war conflicts, but ethnic polarisation does (Montalvo and Reynal-Querol, 2005 and 2010). Moreover, income inequalities and population have a positive effect on the duration of civil military conflicts (Collier et al., 2004). Therefore, it is not surprising that with the creation of nation-states certain minorities could suddenly become an important political factor in a new country, which could lead to a renewed conflict.

Studies that link population trends to stock and fixed-income securities markets rely on publicly available financials datasets and ignore the impact of less liquid alternative investments, the volume of which is much larger than that of publicly traded securities. Australia and Canada have accepted funded pension schemes and global ramifications of these and similar decision are about to become more evident in the future. Studies that analyse prices and returns of publicly traded stocks and bonds ignore the fact that many of these superfunds are larger than company pension funds and their diversification policies are not necessarily based on CAPM⁴ postulates. Multiple divisions are requested to specialise in assigned industries, but the funds themselves due to their gigantic size are diversified. Another phenomenon is that these aggressively growing funds avoid publicly traded assets in order to mitigate accusations of manipulating the markets and to avoid potential liquidity and marketability issues. They invest in alternative assets whose market values are difficult to quantify. *When* these pension funds decide to sell privately traded assets the impact will be significant if the sale is not matched by similarly large buyers from other countries populated by comparatively younger populations. Siegel's (1998) concern about the problem of transferring trillions of dollars of baby boomers' assets could be applied to a multitude of countries that accumulate wealth for posterity and future pensioners.

Poterba (2001) indicates that cross-sectional and panel analysis deal with a mixed age and cohort effects. If an individual of age a possesses specific assets at time t , A_{at} , it can be decomposed as follows:

⁴ CAPM leads to the overweighing of assets with smoothed returns in a portfolio. Due to lower correlation and variance these illiquid assets may seem less risky, but the smoothed prices will not reflect their real level of riskiness. In addition, investors in alternative assets select strategies featuring positively skewed and leptokurtic distributions. Downside risks are controlled for, but the upside returns potential remains unconstrained. Therefore, mean-variance optimization will not provide desirable results.

$$A_{at} = \alpha_a + \beta_t + \gamma_{t-a}$$

where α_a is asset demand at age a , β_t is time period specific shift in asset demand and γ_{t-a} is cohort specific asset demand from persons born in $t-a$ period. Panel data can recover two of these three effects, which is caused by the fact that a cohort effect is a combination of age and time effects. However, it is more likely that a cohort and time effect will be present in the sample. Cohorts that lived throughout wars or global crises will have comparatively lower wealth, which is a cohort effect, while the accumulation of wealth throughout booming 90s is a reflection of a time effect.

Cross-country population studies routinely apply *OLS* on pooled time-series and cross-section data. Let us specify the following variables:

y_{it} - the value of the dependent variable representing the individual unit i observed at time t ,

X_{it} - is the it th observation on K explanatory variables.

Using the specification as in Baltagi (1995) and Pindyck and Rubinfeld (1998) in the somewhat changed form the basic panel data equation is:

$$y_{it} = \alpha + \beta X_{it} + \varepsilon_{it}, \quad i = 1, \dots, N; \quad t = 1, \dots, T \quad (4.1)$$

where $\varepsilon_{it} = u_i + v_{it}$. It is important to distinguish that u_i is unchanged over time and varies across individuals, while v_{it} denotes the common disturbance term that freely fluctuates in time-series and cross-sectionally.

In the vector form the eq. 4.1 is presented as follows: $y = \alpha \mathbf{1}_{NT} + X\beta + \varepsilon$ (4.2), and more generally $y = Z\delta + \varepsilon$. The decomposition of the error term in the vector form implies: $\varepsilon = Z_\mu u + v$ (4.3).

The combination of eqs. 4.2 and 4.3 renders:

$$y = \alpha \mathbf{1}_{NT} + X\beta + Z_\mu u + v \quad (4.4),$$

i.e. $y = Z\delta + Z_\mu u + v$.

The model is evaluated using OLS estimation and implies extensive calculation due to the inclusion of N individual dummies.

$$\text{The eq. 4.4 is multiplied by } Q: \quad Qy = QX\beta + Qv \quad (4.5),$$

since the intercept part followed by the time-invariant disturbance term has trivial solutions.

$$\text{The modified OLS estimator is therefore: } \tilde{\beta} = (X'QX)^{-1} X'Qy \quad (4.6).$$

Important Issues in Population Studies

This procedure is similar to the GLS procedure that also renders the similar result. If eq. 4.2 is rewritten for the simple regression, and averaged across all observations we obtain: $\bar{y} = \alpha + \beta\bar{x} + \bar{v}$ (4.7).

Suits (1984) attaches particular attention to the fact that $\sum_{i=1}^N u_i = 0$, for it assures the avoidance of the dummy variable trap caused by perfect multi-collinearity. Another potential pitfall is the large loss of degrees of freedom because of the N-1 additional parameters that are to be estimated.

Greeny (2000) underlines that the initial formulation (eq. 4.1) can be transformed by the deviations from the group means and in terms of group means that can be consistently estimated using OLS. The author also presents ways of calculating within- and between groups β by calculating moment matrices.

Finally, the OLS estimator is denoted as the summation of the product of aforementioned beta vectors and moment matrices terms:

$$b^t = [S_{xx}^w + S_{xx}^b]^{-1} S_{xx}^w b^w + (I - [S_{xx}^w + S_{xx}^b]^{-1} S_{xx}^w) b^b \quad (4.8),$$

where superscripts have the following notation *t*-total, *w*-within groups and *b*-between groups. The major challenge in using OLS analysis is that population cohorts are arbitrarily determined and the selection of population ratios affects statistical results and policy suggestions.

In order to address non-stationarity of variables that mainly affect results in this area of research Arnotts and Chaves (2012) apply age polynomials. It is also possible to evaluate the joint effect of all demographic variables and the procedure replaces the *ad hoc* use of age groups.

$$r_t = \alpha + \gamma X_{t-1} + \beta_1 s_t^{(1)} + \dots + \beta_N s_t^{(N)} + \varepsilon_t; \quad (4.9)$$

r_{t-1} is return on bonds, equities or growth rate in GDP, respectively. β s are demographic variables, *X_{t-1}* are control variables, *s_t(i)* are age groups. Demographic coefficients are constrained:

$$\beta_i = D_0 + D_1 i + D_2 i^2 + \dots + D_k i^k \quad (4.10)$$

When equation 4.10 is included in 4.9 the following equation emerges:

$$r_t = \alpha + \gamma X_{t-1} + D_0 + D_1 \sum_{i=1}^N i s_t^{(i)} + D_2 \sum_{i=1}^N i^2 s_t^{(i)} + \dots + D_k \sum_{i=1}^N i^k s_t^{(i)} + \varepsilon_t \quad (4.11)$$

In order to eliminate multicollinearity with the intercept, the following restriction has been implemented: $\sum_{i=1}^N \beta_i = 0$ and *D₀* has been modified to:

$$D_0 = -\frac{1}{N} [D_1 \sum_{i=1}^N i + D_2 \sum_{i=1}^N i^2 + \dots + D_k \sum_{i=1}^N i^k] \quad (4.12)$$

And the final equation becomes:

$$r_t = \alpha + \gamma X_{t-1} + D_1 \sum_{i=1}^N \left[i S_t^{(i)} - \frac{i}{N} \right] + D_2 \sum_{i=1}^N \left[i^2 S_t^{(i)} - \frac{i^2}{N} \right] + \dots + D_k \sum_{i=1}^N \left[i^k S_t^{(i)} - \frac{i^k}{N} \right] + \varepsilon_t$$

(4.13)

Polynomials change the weights for age groups in order to obtain stronger variables. Changes in demographic shares show that stock and bond returns increase for the 40-64-year cohort and decline thereafter. It seems that the use of econometric techniques rendering results without need to specify cohorts or ignore unit root issues is a good foundation for future research.

5. Conclusion

Population migrations have allowed human beings to settle down in the most remote regions of the globe and in the modern world population studies have become quite important due not only to economic, but also sociological and political reasons. Since the end of WWII a so-called Baby Boom generation in the US has contributed to the commendable economic development and wealth creation that is unlikely to be repeated by generations immediately following babyboomers. While attempts have been made to link population shifts to returns in stock and bond markets it is evident that the evaluation process is burdened with methodological and data limitations. Econometric techniques assume additional constraints or provide results confounding more than one factor. Recently, it has been demonstrated that polynomials could be used as a solution to arbitrary cohort selections and unit-root problems that generally characterised population studies.

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Important Issues in Population Studies

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BITNA PITANJA U STUDIJAMA POPULACIJE

Rezime: Studije populacije u oblasti finansija pod snažnim su uticajem hipoteze životnog ciklusa utvrđenoj u Ekonomiji Modiljanija i Blumberga (1956). Iako ne nedostaje savremene literature u ovoj oblasti, izgleda da još uvek nema konsenzusa u pogledu značaja studija populacije i metodologije koja se može primenjivati u analizi, posebno kada je reč o finansijskom sektoru. Inputi su prilično neprecizni ili uprosečeni, što može imati negativan efekat na vrednost dobijenih koeficijenata korelacije ili vrednost volatlnosti. Datum obavljanja popisa stanovništva se ne poklapa u svim državama, detaljni popisi se vrše obično u desetogodišnjim intervalima, a promene između popisa se po pravilu obuhvataju na osnovu procena, koje su redovno neprecizne. Sa uvećanim međunarodnim migracijama radne snage i sve brojnijim lokalnim vojnim sukobima procene populacije postaju čak i manje precizne nego što su to bile ranije. Još jedno ključno pitanje, koje može imati politički motiv, je povećanje prosečne starosti zapadnih društava, čija privreda možda neće biti sposobna da apsorbuje stranu radnu snagu uz stalno povećanje radnog kontingenta, ali ipak zahteva svež priliv radne snage kako za nisko-plaćene poslove tako i za druge konkretne poslove koje izbegava lokalna populacija. Pored ovih problema, glavno ograničenje i dalje ostaje u oblasti evaluacije modelima. Da bi se primenila regresiona analiza varijable moraju imati obeležje stacionarnosti. Ipak, u oblasti studija populacije sa primenom u finansijama izvesne varijable populacije ne pokazuju stacionarnost, intervali za analizu starosnih kategorija proizvoljno se određuju a rezultate je teško uopštavati zbog pomenutih ograničenja.

Ključne reči: studije populacije, popis stanovništva, finansijska tržišta.