Spatial Demography ***2014*** 2(2): In Press
http://spatialdemography.org

OPEN ACCESS
via Creative Commons 3.0

ISSN 2164-7070 (online)

RESEARCH

The Future of Urban Projections: Suggested Improvements on the UN Method

Philippe Bocquier[1]

[1] Université catholique de Louvain, Belgium

ABSTRACT

This paper argues that imperfect data should not hinder the search for alternative projection models and methods. Given the available data on urbanization, autoregressive projection models should be preferred to explanatory models for projections though explanatory models are more suitable for analyzing past trends. Alternatives to the UN's projection method, Bayesian projection included, should account for the social and economic inequalities embedded in the global, national and sub-national urban systems.

KEYWORDS: urban projections, projection methods, Bayesian models, world inequalities, urban systems

The intensive use of the United Nations' World Urbanisation Prospects database[1] (hereafter referred as WUP) belies growing concern in the scientific community about United Nations urban projection methods and results. Very few successful attempts have been made to offer a better alternative to the UN database that would be comparable in scope and regularity of publication. Certainly the national data sources that form the basis of the UN database are criticized (Hugo and Champion 2003), mainly for the data inconsistencies observed in less developed countries (LDC) and for the difficulty associated with the lack of comparable definitions of urbanization across countries (see article in this volume by Buettner). The quality of the data used for projections has a bearing on the choice of projection method, and therefore the paper begins with a brief overview of data sources and limitations. However, the weakness of urban projections does not principally lie on data quality but on modeling. The remaining of this paper will focus on shortcomings in the methodology and make suggestions for future directions in modeling.

Data or why we should not wait for the better

The lack of reliable data is a basic concern for urban population projections. The UN Population Division makes a strenuous and commendable effort to produce the WUP every two years. Because the publication cannot wait for all data to become available, it makes use of an inherently incomplete series. The WUP-2011 considers 2011 as its last observation year, but the last

1 The *World Urbanization Prospects* database refers to the publicly available estimates and projections for urban and rural, population and cities for locations greater than 750,000 persons, as described by Buettner in this volume.

Corresponding Author: Philippe Bocquier, Professor, Centre de recherche en démographie et sociétés IACCHOS, Place Montesquieu 1, bte L2.08.03, B-1348 Louvain-la-Neuve. Tel: 32 (0)10 47 41 83. Fax: 32 (0)10 47 29 52.
Email: philippe.bocquier@uclouvain.be

observations were made on average for the year 2004.9, i.e. 2005.6 for developed countries and 2004.6 for developing countries. For 108 countries or territories out of 230 (47.0%), the last observations were made in 2005 or before and for 36 of them (15.7%) in 2000 or before, while 41 countries (17.8%) provided estimates for the years 2010 and 2011. This means that for most countries estimations for the years 2010 or 2011 are already based on projections. The older the last estimate, the higher the likelihood of error in projections. Another concern is with unequally spaced series produced by the countries. While many developed countries produce urban estimates at regular intervals (often based on censuses), most LDC estimates are produced at very uneven time interval. Missing years are interpolated to produce WUP yearly time series estimates and projections. Obviously, shocks such as wars, civil conflicts and severe economic crises may lead statistical systems failing to provide figures at national level. These shocks are associated with lack of observed (yearly) estimates at or around the time of these shocks and therefore with smoothed interpolated urban estimates that do not account for the disturbed historical reality. While this has probably little effect on long-term projections, it certainly removes variations that would otherwise serve analytic purposes.

Much concern has been expressed about the lack of a standardized, globally accepted definition of urban areas. Definitions may vary across country and within countries over time. This definitional heterogeneity is not a major concern if the principle of country-by-country projections is accepted as it tends not to affect national projections, though there are some inherent difficulties when countries change definitions (NRC, 2003). Definition heterogeneity is, however, a drawback for pooled (regional, continental, world) projections. Furthermore, undocumented changes in definition are a major source of error for both national-level estimation and projection. This particularly affects less developed countries with weak national statistical offices or frequent unrest or wars, which might not only affect data collection but territoriality and jurisdiction (Hugo and Champion 2003). The more recent the change in definition, the higher the likely baseline error it introduces in a projection.

Despite this, the lack of reliable, timely, and regularly collected data is not the main concern for projections. Demographers, together with geographers, are more worried about projection methodology. Several publications have shown that the UN method for urban projections has not fit past trends well, and has overestimated future trends (National Research Council 2003; Cohen 2004; Bocquier 2005). I have shown that the UN method, developed in the 1980s when few urban data were available, is based on the assumption of convergent transition to high level urbanization– and on the use of an incorrect assumption of linearity of the transition process (Bocquier 2005). Conforming to the mobility transition theory (Zelinsky 1971) using WUP data, fitting curvilinear past trends country by country (see following section), and employing the concept of urban saturation – i.e., the ending point of the urban transition process when the urban capacity reaches its limit, and which may evolved over time and differ from country to country according to its position in the world economic development–gives a much better fit to observed data and probably improves projections based on these data (Bocquier, 2005). To note, although this saturation point conforms to the theory, it is not known in advance or imposed as a parameter. Only the curvilinear shape is imposed, and is fitted on past trends as explained in the following section. Also, the advantage with country-specific projections is that they are not constrained by country-to-country variation in urban definitions.

Nonetheless, country-specific projections have their own limitations. Although projections on urban-rural growth differentials are less subjected to definitional bias than projections on the percentage urban or on the volume of the urban population, urban growth may not be homogenous across towns and cities. For example, higher growth in small towns (below a given urban threshold, say, 20,000 inhabitants) than in bigger cities (above that threshold) may result in low overall urban growth, resulting in so-called counter-urbanization, although urbanization is actually spreading to “rural” areas. With similar size-dependent growth pattern another country with a different threshold (say, 10,000 inhabitants) or a change of threshold in the same country will result in different overall urban growth trend. Also, country-level projection may be hindered by the sheer lack of data, as often the case in developing countries. Using some kind of pooled data projections for countries with limited or missing series may help fill the data gap. I will come back in the last section of this paper on the benefit of using regional data and the concept of interdependency of urban systems.

Waiting for comparable, reliable data would unduly delay the effort in designing projection models. Much can be done with existing data as long as inconsistencies are checked and controlled. The primary concern is with the projection model. The upward bias associated with the UN method is actually higher in countries offering reliable, regular, recent and documented data. The upward bias is also observed in LDCs but the impact of the bias is higher since these countries are also the most populated in the world (Bocquier 2005). Waiting for comparable and reliable data will not sufficiently improve the projections, if the model is based on a false interpretation of historical trends.

This paper makes suggestions for alterations to the foundation of future urban projections. It is not meant as a full review of the projection methods (for this, see O'Neill et al. 2001). This paper will show that the lack of reliable data should not hinder the search for alternative projection models and methods. Given the available data on urbanization, autoregressive projection models (also referred to as extrapolation projection models) should be preferred to explanatory models though explanatory models are more suitable for analyzing past trends. In designing alternatives to the UN’s projection method, the greatest difficulty is putting urban trends into the larger perspective of global development. This paper will develop the profile of an urban projection model that will be able to account for the social and economic inequalities embedded in the global, national and sub-national urban systems.

MODELS AND METHODS

Endogeneity or why knowledge does not improve forecasts

Projections based only on past trends, such as those in the WUP, rely on autoregressive models – i.e., the estimates for time *t* are computed on the series of estimates before time *t*. They are not explanatory by nature – that is, the determinants of urbanization are not explicitly used as parameters in the estimation of past trends or in forecasting. Instead, these autoregressive time-series models take their predictive power only from the mathematical function imposed on the relationship between estimates at different points in time. They are attractive due to their apparent simplicity.

Because they are just based on past trends, one could argue that autoregressive, non-explanatory models are necessarily worse than explanatory ones that use a number of parameters. This argument is based on the recognition that human systems are complex and on the acknowledgement of the progress of micro-studies and behavioral analyses at large (Lutz and Goldstein 2004). Certainly urbanization trends are highly correlated with other indices of economic and human development. For example, Fox (2011) found significant and positive effect of population growth and GDP growth on urbanization and urban population growth, based on an autoregressive model with lag covariate values. But when it comes to projection, explanatory models (also known as structural models) become very difficult to implement. First, the covariates X measuring economic and human development may themselves be hard to collect at regular intervals. As a consequence, the model often relies on projected parameters, resulting in dubious ‘projections on projections’. Second, explanatory models rely on hypotheses that may fail to hold over the estimation or projection period, and may be sensitive to the specification of the model (error in measurement of the covariates, complex interactions between covariates, unobservables, etc). Third, and most importantly, urbanization and the level of development as measured by covariates X may be endogenous to each other, i.e. development may cause urbanization as much as urbanization may cause development. No developed country is poorly urbanised; no developing country can expect to raise its economic position relative to other countries without increased urbanisation. While it is useful to identify the components of the urbanization process, their observed temporal relations are necessary but not sufficient conditions for causality. This endogenous relation is already difficult to deal with when analysing past urbanisation trends but it is even more so in projecting these trends.

The main interest of autoregressive models without covariates is to provide the horizon for national urban projections. Despite the lack of a common standard definition of urbanization among countries, the country-by-country projections are useful in providing a world of possible alternatives. I have shown that an autoregressive model is quite effective in predicting urban trends by fitting country-specific time series of the Urban to Rural Growth Differential (URGD) against the proportion urban using a polynomial, curvilinear function. In this way, I was able to fit the country-by-country 1950-1980 trends and predict the 1980-2000 trends quite well (Bocquier 2005), with the main results for selected countries reproduced here as Figure 1. This polynomial model differs from other autoregressive models that converge to a given urban saturation point at the limit (when the urban growth becomes nil), such as that used in the World Urbanization Prospects. The polynomial model does not impose a fixed limit and even fits the counter-urbanization phenomenon that has been observed in a few countries when the urban-rural growth difference is less than zero. Further refinements to the polynomial form of this basic autoregressive model can be made by using a polynomial function of degree 3, and by stipulating that the fitted curve start at the point of origin (when the proportion urban is nil). This model has been tested on WUP-2009 data and compared with the polynomial of degree 2. The two models give about the same projections (Bocquier and Mukandila 2011). Whatever the refinements, the performance of the simple polynomial model has already proven that existing time series data, using the simple urban-rural divide can be sufficient to produce fairly credible urban projections.

The polynomial model was used for projections up to 2050, although there is no technical reason for not projecting trends beyond that symbolic date. It should be noted that according to these projections most countries would already have reached urban saturation by that date, which makes it unnecessary to prolong the trends much beyond 2050. However, this is partly an artifact of the autoregressive modeling procedure: as the projected trend progresses in time, less weight is given to observed data and more to projected data. Though only future will tell, this method like any other autoregressive projection may lead to conservative endpoints (when urban growth is virtually zero) that contrast with the uncertainty necessarily attached to long-term projections. Data collected up to now reflect a particular historical context that may change over the next century. There is no guarantee that observed urban trends will prolong and that urban systems will reproduce the same way. Obviously, no projection method (UN or otherwise) may account for breaks in trends due to changes in the economic or political circumstances. Available projections are reflecting essentially post-second World War history more than the future.

The observed and projected values can be aggregated by level of development, as conventionally categorised by the UN into more, less and least developed countries. The less developed countries usually include the least developed countries, but in the Figure 2 and 3, we deducted the least from the less developed countries to form an 'intermediate' category. Note the peculiarity of the observed trend for the intermediate region: the sudden drop on the left-hand side coincide with the Cultural Revolution in China (see Figure 1) which led to a virtual standstill in the urban transition. The

Figure 1: Urban-Rural Growth Difference (Observed, Polynomial Model and UN Model) versus Proportion Urban for Sweden, Mexico, India, China

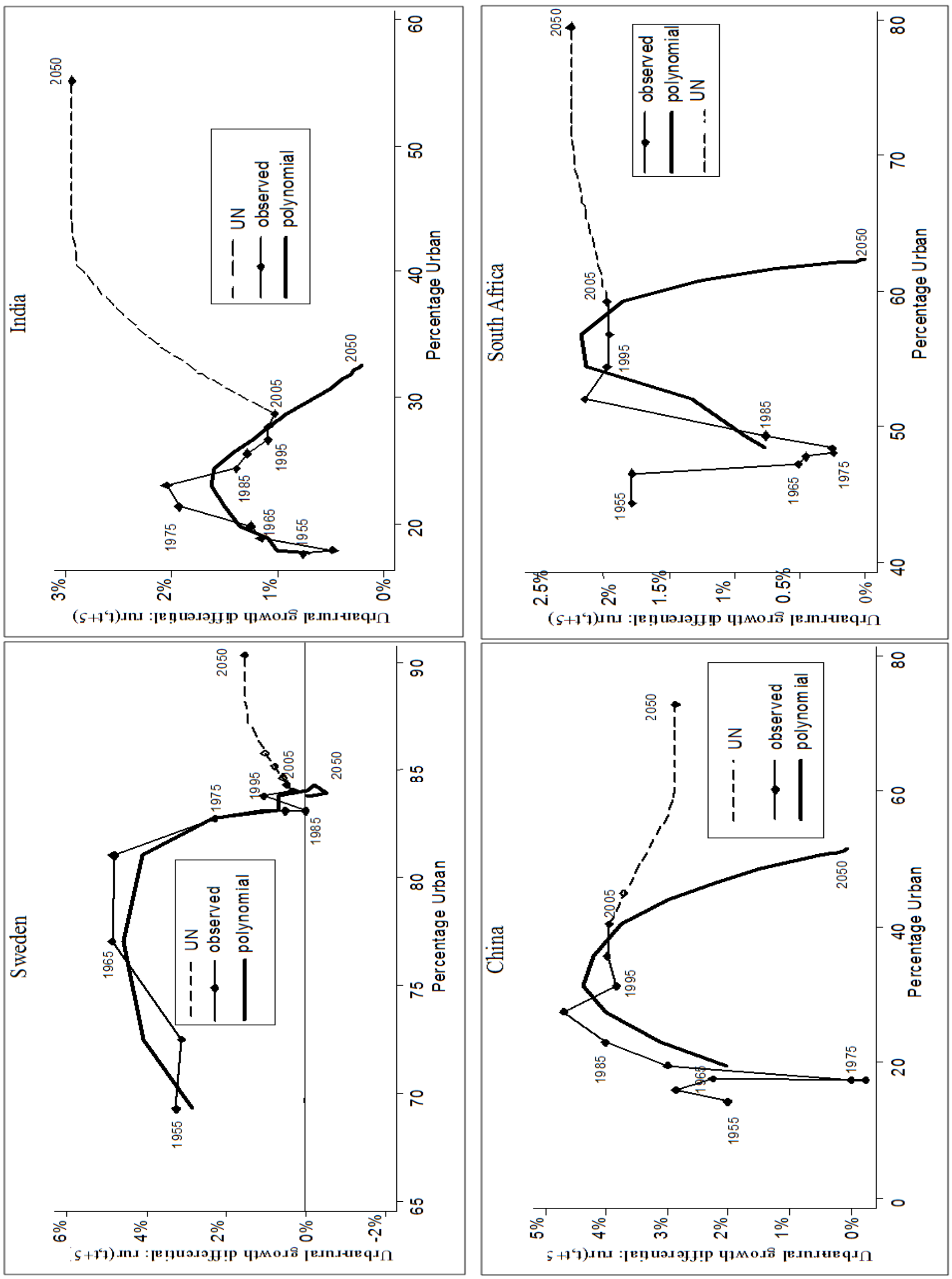


Figure 2. Urban-Rural Growth Difference (Observed, Polynomial Model and UN Model) versus Proportion Urban for More developed countries and Least developed countries.

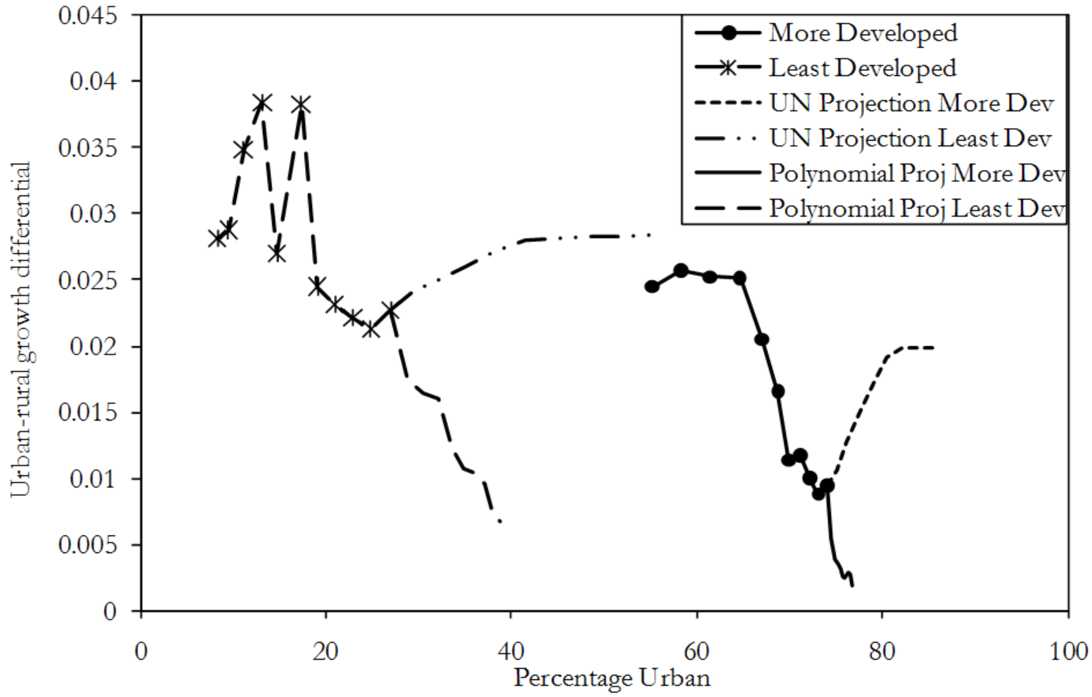
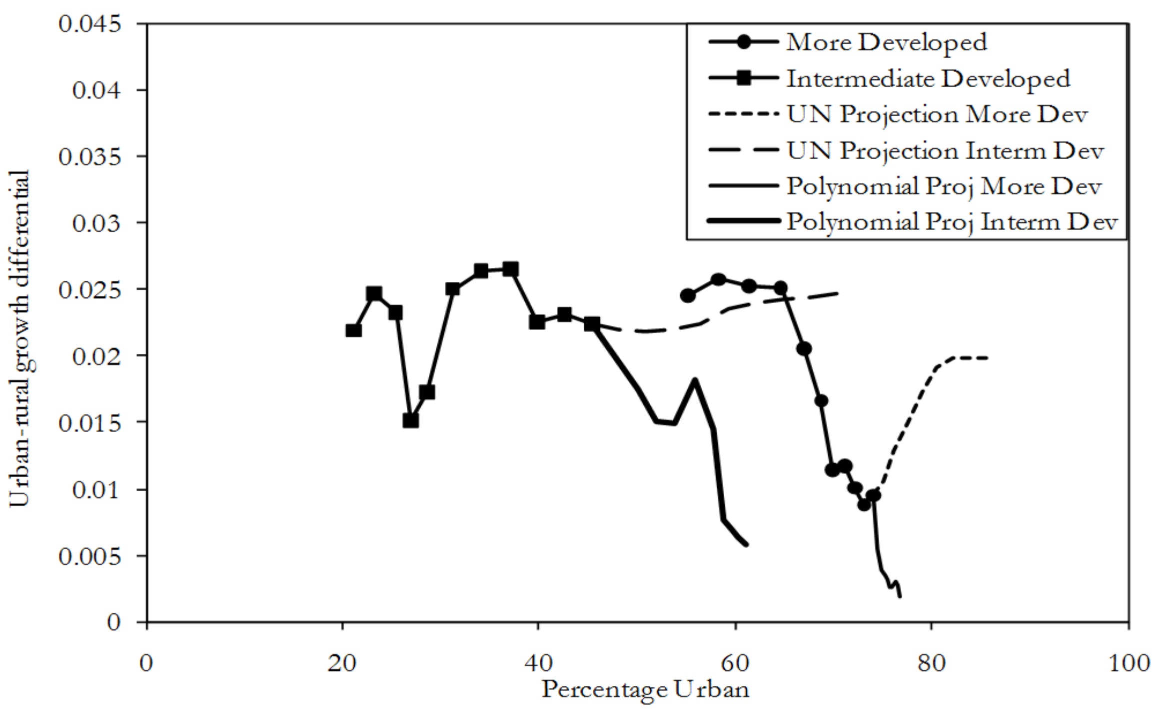


Figure 3. Urban-Rural Growth Difference (Observed, Polynomial Model and UN Model) versus Proportion Urban for More developed countries and Intermediate countries



fluctuations in early trend for the least developed region are mainly due to unreliable urbanization data up to the 1970s. The results of the two types of projection are staggeringly different. UN projections show a departure from the historical trend. Polynomial projections show on the contrary a trend toward a saturation point below 80% urbanization for the more developed region, 65% for the intermediate region, and 45% for the least developed region. The world would be 57% and 59% urbanized respectively in 2030 and 2050 according to the polynomial model, against almost 60% and 70% respectively according to the UN model. To note, these figures may change depending on the urban definition used by each country, in particular China where the tedious definitions used in the past and present[2] are very different from the 10,000 population threshold commonly used by scientists and by many countries.

The endogeneity of urbanization and other dimension of development is a consequence of cities and towns forming part of the modern world-system characterised by the dominance of the capitalist mode of production, interstate competition for resources, and core/semi-periphery/periphery hierarchy (Chase-Dunn 1998). Technological advances and political regimes are factors that greatly influence the urbanization process (Davis and Henderson 2003; Henderson 2003). When designing urban projection models, one must identify the structure of the urban system at play. There are several layers of urban development, from the very local (a town and the surrounding villages) to the very global (mega-cities in relation with each other and a network of dependent cities). Urban development at each of these hierarchical levels is constrained by the structural evolution of the world-system. This is probably why, however complex the interactions between the urban system's social and economic components may be, these components cannot act beyond the horizon set by the evolution of the system at a higher, international level. Even with well-defined measures of urban development components, use of time lags or sophisticated statistical modelling, the multivariate approach does not necessarily out-perform autoregressive (univariate) approach (Chi 2009).

Can urban transitions of the past help modeling the on-going transitions? Recent projections of overall population growth, as well as mortality and fertility by the UN make use of Bayesian statistical models, under the assumption that past regional or global experiences are the best prior distributions (Alkema et al. 2011; Raftery et al. 2012; Raftery et al. 2013a; Raftery et al. 2013b). The same principle may hold for urbanization with a caveat that current transitions are observed in developing countries while past (ending) transitions have occurred in developed countries. In other words, countries with currently low level of urbanization are not lagging behind by chance, but because of their historical position in the global economy. As already pointed by Zelinsky (1971) the transition modalities depend on the moment the transition started. This heterogeneity in transition does not mean that the transition obeys different laws in different parts of the world, but that the experience of early transitions makes late transitions occur faster but not necessarily with the same endpoint. European countries took two

2 WUP2011 data source Urban Population, China: "Up to 1982: total population of cities and towns. Cities had to have a population of at least 100,000 or command special administrative, strategic, or economic importance to qualify as cities. Towns were either settlements with more than 3,000 inhabitants of whom more than 70 per cent were registered as non-agricultural or settlements with a population ranging from 2,500 to 3,000 inhabitants of whom more than 85 per cent were registered as non-agricultural. For the 1990 census, the urban population included: (1) all residents of urban districts in provincial and prefectural-level cities; (2) resident population of "streets" (jiedao) in county-level cities; (3) population of all residents' committees in towns. For the 2000 census, the urban population was composed of population in City Districts with an average population density of at least 1,500 persons per square kilometer, other population in suburban-district units and township-level units meeting criteria such as "contiguous built-up area," being the location of the local government, or being a Street or having a Resident Committee. For the 2010 census, urban population included all urban residents meeting the criterion defined by the National Bureau of Statistics of China in 2008, i.e., the criterion used in the 2000 census plus residents living in villages or towns in outer urban and suburban areas that are directly connected to municipal infrastructure, and that receive public services from urban municipalities." (Downloaded 19 June 2013).

or three hundred years to reach high current urbanization levels, while it took less than half a century for others (Dyson, 2011). However, not all countries may reach high levels of urbanization. Bayesian projections, although much better than deterministic projections that impose a fixed target for all countries, should account for the heterogeneity of the timing and intensity of urban transition over the world. The next section explains why the interdependency of urban systems imposes to account for both the time and spatial dimensions of the urban transition.

Interdependency or why size and space matter

The urbanization trends projected at the countries level are just one possible level of projection. Urban development occurs at different hierarchical levels and necessitates a good understanding of the urban hierarchy. World comparisons of urbanization are hindered by the different population thresholds used across countries to classify particular locations as urban. An alternative to current projections that use such national definitions would be to make projections for each subset of cities classified by population size. Projections could be done in each country for cities above 500,000 inhabitants, and then compared with projections for cities above 100,000, 50,000 and 20,000 inhabitants. This would be useful for users who need to work on projections disaggregated by city-size. Furthermore, comparison of the different city-size projections, if showing some linearity, may help to determine a likely “standard” urbanization rate at a lower threshold (e.g. 10,000 inhabitants). This standard could be compared to the “official” urbanization rate to evaluate the sensitivity of urban projections to the choice of a population threshold or set of alternative criteria.

Urban growth has two components: migratory and natural (i.e., difference between fertility and mortality). Historically, cities grow by migration mainly in the early stages of urbanization and then by natural increase. An important contributor of the difference between urban and rural growth is the age structure, which is in itself a consequence of migration at earlier stage of urban development. In other words, migration has a lasting effect: first, as a direct effect through migration flows at the beginning of the urban development; second, at a later stage, as an indirect effect through the young age structure that youth migration creates, and which is only partially compensated for by lower fertility in urban areas (Chen et al. 1998). But as natural increase slackens with economic development, migration can again emerge as a dominant factor although the quantitative roles of migration and natural increase remain to be documented in our increasingly urbanized world. Multi-state projection methods could explicitly model the respective contributions to urbanization of mortality and fertility on one hand, and of migration, on the other hand. This can be done by age-group, resulting in more precise projections of the age structure of the population in both urban and rural areas (O'Neill and Scherbov 2006). To be sure, such urban projections would rely not only on national-level fertility and mortality estimates, but also on a number of hypotheses and detailed data on migration trends, although these are increasingly becoming available (Cohen et al., 2008).

The evolution of a city cannot be fully understood without reference to the history of the city, and its relation to other cities and rural areas. Understanding the dynamics of organization and population within a capital city does not prevent us from understanding dynamics of the city in relation to other cities. In turn, understanding the dynamics between a set of cities, towns and villages in a given country does not prevent us from understanding the relationship between this country’s urban system and other countries’ systems. A particular (and relatively easy to achieve) effort should be made for projections at the state/provincial level in large countries (China, India, USA, Brazil, Indonesia and so forth). In fact, province-level urban projections for large countries might easily be seen as comparable to national-level projections for smaller countries. Recognizing an urban system does not exhaust or negate smaller or bigger ones. Cities are not isolated entities; they are members of interdependent urban networks through which they affect each other by exchanging human and material resources, services, and so forth. Cities do not function independently from each other, in a given country or in the world. Thus, an ideal urban projection model should recognize these dependencies of cities at different population sizes (and other characteristics) within the network. Positing that there are several inter-connected or hierarchical urban systems, it should be possible to make coherent projections at the intra-national, country, regional, continental, and global levels, and to compare projections at one level with projections aggregated at coarser levels. It should be noted that while country-level and global projections are commonplace, projections at the subnational and regional (set of neighboring countries) levels are uncommon.

Needless to say, accounting for national and international urban hierarchies in an explicit way in an urban projection model would be far more complicated than accounting simply for the trends in rural and urban population sizes of a given country. Take an extreme example: A national urban population projection reaches its obvious limit when the country/territory in question becomes… 100% urban! After reaching this absorbing state, no further projections (based on an urban to rural growth differential) are informative. In most other cases, urban saturation may be reached well below 100%, as already observed in most developed (e.g. Sweden in Figure 1) and intermediate countries. However, cities may continue to evolve in size and rank in relation to the national or international system, even after reaching urban saturation point. Urban growth models that explicitly model the geographical extension of urban agglomeration highlight one source of such changes (Montgomery and Balk, 2009). The proximity of cities to each other, sometimes over national boundaries, and the physical limits created by water (rivers, lakes and oceans) or by other natural constraints (mountains, desert, etc.) would be other parameters to include in the modeling. So, too, are the links that connect city systems across national boundaries. A country/territory can depend on other urban systems of which it is also a part, notably through international migration and economic dependencies. National borders tend not to function as firm boundaries for city-state type countries or territories like Singapore, Djibouti, Gibraltar, etc., which are 100% urban but embedded in a complex and evolving relationships with cities in distant as well as neighboring countries.

This discussion raises difficult questions of defining spatial boundaries and limits to urban systems. It might be thought that the smaller is a city or town, the smaller is the urban system on which it directly depends. Like Russian dolls, some urban systems of different scales are nested. Unlike Russian dolls, and more like the magician's rings, some small urban systems may be linked to two or more higher-scale urban systems at the same time, and these larger systems are not necessarily in the same country. One sub-national urban system can be embedded directly into an international one or indirectly by proxy with another, sub-national urban system.

Targeting urban systems means that projections should ideally be made within the limits of these urban systems. But what are these limits? Certainly, they should include some kind of geographical criteria, such as contiguity, though even this can be questioned. Islands constitute interesting cases in the study of international urban systems. Not only are they not subjected to direct border effect (in that they have no contiguous neighbors), but islands often depend on a remote former colonizing-country for their development and migration streams. Indeed "neighbors" of many types (such as trading or cultural neighbors, rather than those specified by a strict contiguity criterion) could be including in such modeling. Measures of spatial correlation often used to detect bias in statistical modeling, here could be used to identify urban systems. However, more work would first need to be done on the extent of urban systems as measured by spatial correlations. Gravity models, also called spatial interaction models, are a source of inspiration though they have been mainly applied to migration so far (Stillwell 2005, Cohen, 2008), and more recently, forecasts of spatial population distribution (Jones and O'Neill, forthcoming).

Although highly complex as we have suggested, there are fundamental hierarchies evident in different urban systems, with hierarchies reflecting unequal development and economic dependency. To account for the complexity of urban systems in an unequal world, it is important to analyze the links between cities and towns in the same country and across countries, through migration, commercial, investment, and communication flows. The matrix of these flows should help us to delimit the urban systems and understand their inter-connections. The relative intensity index proposed by Courgeau (1988) and mainly used in migration analysis (Tremblay, 2001; Bocquier & Traoré, 2000; Bocquier, 2003), can be easily expanded to any kind of exchange flows and will prove useful for analyzing urban networks. The intensity is computed by dividing a flow (e.g. migrations) by the product of the stocks (e.g. populations) at origin and at destination. This ratio is then divided by the mean intensity to form the relative intensity index. Cluster analysis based on this relative intensity index may be used to determine the limits of spatial correlations. This should enable us to set the limits of urban systems on which to make projections.

CONCLUSIONS

Model checking

Uncertainty should be attached to projected estimates so that the projections are made in probabilistic rather than deterministic terms. Estimates of uncertainty should go beyond the traditional 'mean, low, high' scenarios to include computed confidence intervals around mean projections. Where the projection model cannot readily offer such intervals, confidence intervals should be computed using simulation techniques and checked against the theory for internal consistency, as is done for IIASA's overall population projections (Lutz et al. 2004; O'Neill et al. 2001). Bayesian model now used by the UN Population Division for its demographic projections is another promising projection technique that provides confidence intervals. Equally important is to look at the external consistency of urban projections with the different demographic variables (migration, fertility, mortality) that explain urban growth. A step in that direction would be to provide mortality and fertility projection separately for each area of residence (urban-rural, or along any other urban hierarchy, including at big city-level) where data are available. But this would not provide estimates on a crucial component of urban growth: migration. Long-term migration trends are difficult to measure and even more to model as they are more volatile than mortality and fertility trends. Projecting overall urban growth, without consideration of its natural or migration components, still has its advantages while waiting for more comprehensive, systemic models and suitable data to run them. (See Kim and Montgomery, this volume, for a city-growth model which begins to move in this direction.) External consistency should also be sought with other social and economic variables. Typically, low (high) projected urbanization should be consistent with fairly low (high) projected level of education, health, wealth, etc. The urbanization trends offer, as demographic variables often do, a horizon for future overall development. The urban projection model should acknowledge the social and economic inequalities embedded in the global, national and sub-national urban systems.

Other considerations force modesty. First, projection models may fit relatively well past trends (e.g. those measured from the 1950s), but nevertheless prove wrong theoretically and consequently project future trends badly. Best fit is a necessary but not sufficient condition to prove the theory. Second, a change in the urban system evolution may occur if history has modified the old causal mechanism in ways that alter the terms of future growth, however well the past was captured by the model. China (see Figure 1) and South Africa offer such examples of major disruptions in urban evolution caused by political history: the Cultural Revolution and the Apartheid Regime led first to a virtual halt in urban growth and second, after recognition of their failure, to very rapid urban growth respectively in the late 1970s and the late 1980s. In other words, causal relationships may be unstable over time. Projection models will never be able to account for the accidents of History and the end of a transition period may be followed by another transition period under different rules. Nevertheless, unless one has strong arguments for revising historically-based assumptions, past trends should be used as a benchmark not only for model checking but also for projections consistency check. Projections techniques should first be tested on recent past periods, and when consistency is found, extended to future periods. Projections models should take advantage of the fact that demographic behaviors remain among the rare outcomes of human activities that show a high degree of inertia. Any departure from past trends should be considered either as errors in the model or as hypothetical scenarios, i.e., closer to predictions than to projections.

References

Alkema L., A.E. Raftery, P. Gerland, S.J. Clark, F. Pelletier, T. Buettner, G.K. Heilig (2011). Probabilistic Projections of the Total Fertility Rate for All Countries. *Demography* 48(3):815-839. doi: 10.1007/s13524-011-0040-5.

Bocquier, P., and S. Traoré (2000). Urbanisation et dynamique migratoire en Afrique de l'Ouest - La croissance urbaine en panne. Paris: L'Harmattan, p. 148.

Bocquier, P. (2003). « *L'importance relative de la fuite des cerveaux : la place de l'Afrique sub-saharienne dans le monde* », in Diasporas scientifiques - Scientific Diasporas, éd. par R. Barré, V. Hernandez, J.-B.Meyer, D. Vinck. Paris: IRD Editions, pp. 160-177.

Bocquier, P. (2005). World urbanization prospects: an alternative to the UN model of projection compatible with urban transition theory. *Demographic Research* 12(9): 197-236.

Bocquier, P. & Mukandila, A. 2011. “African Urbanization Trends and Prospects”, *African Population Studies*, 25th Year Commemorative Edition, 25(2):337-361.

Chase-Dunn, C. (1998). *Global Formation. Structures of the World-Economy*. Updated edition. Lanham, Maryland, Rowman & Littlefield.

Chen, N., Valente, P. and H. Zlotnik (1998). What do we know about recent trends in urbanization? in Bilsborrow, R. (ed) *Migration, urbanization and development, new directions and issues*. UN Population Fund and Kluwer, Dordrecht.

Chi, G. (2009). Can Knowledge Improve Population Forecasts at Subcounty Levels? Demography 46(2):405-427.

Cohen, J. (2008). J., M. Roig, D. Reuman, and Cai Gogwilt (2008). International migration beyond gravity: A statistical model for use in population projections. *Proceedings of the National Academy of Sciences* 105(40):15269-15274.

Cohen, B. (2004). Urban Growth in Developing Countries: A Review of Current Trends and a Caution Regarding Existing Forecasts. *World Development* 32(1): 23-51.

Courgeau, D. (1988) Méthodes de mesure de la mobilité spatiale. Editions de l’Institut National des Etudes Démographiques.

Davis, J. C. and J. V. Henderson (2003). Evidence on the political economy of the urbanization process. *Journal of Urban Economics* 53: 98-125.

Dyson, T. 2011. “The Role of the Demographic Transition in the Process of Urbanization.” *Population and Development Review*, 37, 34-54.

Fox, S. 2012. "Urbanization as a Global Historical Process: Theory and Evidence from sub-Saharan Africa." *Population and Development Review* 38(2):285-310.

Henderson, J. V. (2003). The urbanization process and economic growth: The so-what question. *Journal of Economic Growth,* 8(1): 47-71.

Hugo, G. and A. Champion (2003). *New Forms of Urbanisation*. Ashgate, Aldershot.

Jones, B. and B. O’Neill, forthcoming. Historically grounded population scenarios for the continental United States, *Environmental Research Letters*.

Keyfitz, N. (1982). Can Knowledge Improve Forecasts?

Population and Development Review. 8:729-51.

Lutz, W., W. C. Sanderson, and S. Scherbov (Eds.) (2004). The End of World Population Growth in the 21st Century New Challenges for Human Capital Formation & Sustainable Development. Earthscan, London.

National Research Council (Ed.) (2003). Cities Transformed - Demographic Change and Its Implications in the Developing World. The National Academies Press, Washington D.C.

O'Neill, B. C., D. Balk, M. Brickman, M. Ezra (2001). A Guide to Global Population Projections. *Demographic Research* 4(8): 203-288.

O'Neill, B. C. and S. Scherbov. (2006). *Interpreting UN Urbanization Projections Using a Multi-state Model*, IIASA, Laxenburg, p. 21.

Raftery, A.E., L. Alkema, and P. Gerland (2013). Bayesian Population Projections for the United Nations. *Statistical Science*. In press. http://www.imstat.org/sts/future_papers.html

Raftery, A., J. Chunn, P. Gerland, and H. Ševčíková (2013). "Bayesian Probabilistic Projections of Life Expectancy for All Countries." *Demography* 50(3):777-801.

Raftery, A.E., N. Li, H. Ševčíková, P. Gerland, and G.K. Heilig (2012). "Bayesian probabilistic population projections for all countries." *Proceedings of the National Academy of Sciences* 109(35):13915-13921. doi:10.1073/pnas.1211452109.

Stillwell, J. (2005). Inter-regional Migration Modelling: A Review and Assessment, *45th Congress of the European Regional Science Association*. Vrije Universiteit Amterdam, Amterdam, p.26.

Tremblay, K., (2001). “Student mobility between and towards OECD countries: a comparative analysis”, in SOPEMI: Trends in international migration. Annual report, Paris (OCDE/OECD), pp. 93-117.

United Nations, (200X). *World Urbanization Prospects: XX Revision*

Zelinsky, W. (1971). The hypothesis of the mobility transition. *The Geographical Review* 61(2): 219-249.