THE THEORY & PRACTICE OF FORECASTING IN PLANNING: A CASE STUDY ANALYSIS OF CANADA MORTGAGE AND HOUSING'S POTENTIAL HOUSING DEMAND MODEL

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A Practicum submitted to the Department of City Planning
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ABSTRACT

The need for projections in city planning and the social sciences were examined. The differences between forecasts and projections were discussed and various forecasting methods surveyed. The relationship between forecast types and planning applications was described.

The Potential Housing Demand Model (PHD Model) of Canada Mortgage and Housing Corporation was examined in detail. An overview of the functioning of the model was presented along with an examination of the three main components of the model: the population projection model, the household projection model and the potential housing demand projection model.

Methods of forecast appraisal were reviewed. The main criteria used by researchers were discussed. Accuracy and theoretical coherence were considered the primary criteria of appraisal by all major researchers in this field of inquiry. Correlates of accuracy were presented and discussed. Finally, a representative sample of past research was summarized and the main findings of these investigations presented.

The rationale of the study was addressed and the following two objectives were stated:

1. To appraise the performance of the Potential Housing Demand Model in a manner consistent with past research.

2. To determine the performance of the PHD model with respect to the following two

general findings of past research:

A) *A forecast time horizon is the strongest and most consistent correlate of its accuracy.*

B) *The essential importance of the validity of core assumptions.*

The results of the case study analysis generally agreed with the two findings of past research except in the household demand component of the model which did not overestimate the overall level of households less accurately as the forecast horizon extended farther out. Also, in contrast to past research, the PHD model actually predicted a more accurate value for household growth for the entire 25 year period than it did for any 5 year census period.

Chapter One

The Need for Predictions in Planning

Forecast: *verb*\\ **1a:** to calculate or predict (some future event or condition) usu. as a result of study and analysis of available pertinent data; **b:** to indicate as likely to occur **2:** to calculate the future **3a** *noun*\\: foresight of consequences and provision against them **b:** a prophecy, estimate, or prediction of a future happening or condition. (Webster's Collegiate Dictionary)

Introduction

What will the future hold? This is the essence of any forecast. Given the past behaviour and current state of a particular topic, what is most likely to occur in the future? Without an idea, or best guess of what the future has in store for us, it becomes impossible to plan for it. Indeed, since its beginning at the turn of the century, urban and regional planning has been largely justified as an institutional mechanism for providing information about the future to guide current decision making (Klosterman 1990).

As Richard Klosterman states in Community Analysis and Planning Techniques (1990, p 4):

"Population projections and forecasts are among the most important local, state, and national planners. Local comprehensive plans for future residential, commercial, and related land requirements are derived from forecasted population levels and projected space needs per capita. Federal, state and local funding decisions for capital facilities such as transportation systems, sewage treatment facilities, and schools are based on the projected number of people who would be served by them".

As experts on future trends, local planners are faced with a particularly difficult task - preparing reliable long-term (20 to 30 year) projections for small areas such as counties, cities, and neighbourhoods. Reliable short-term projections are much easier to arrive at since two or three year demographic and economic changes are generally small. Long-term changes are much more difficult to predict, especially for smaller areas, which makes reliable long-term forecasts difficult to prepare (Klosterman 1990).

A lack of foresight or the failure to foresee or acknowledge trends has contributed, and will continue to contribute, to many of the problems we currently face. Past examples include the energy crisis, which emerged as a result of unanticipated shortages of fuels and inadequate recognition of the implications of the continually growing demand for energy. It is true that for all the technological sophistication of our public and private sectors, the record of forecasting future problems and events is not enviable. Rather than a criticism on past forecasts, this is an acknowledgement of the difficulties of forecasting. Although we may have facts on past patterns and existing relationships, and firm information guides our alternatives, we must still choose between them. It is here that we depart from the currently knowable and where the greatest difficulty lies. Which alternative is more plausible? Which one is farfetched?

that we depart from the currently knowable and where the greatest difficulty lies. Which alternative is more plausible? Which one is farfetched?

This chapter explores and defines models, projections, and forecasts. It also considers some basic types of forecasts used in planning. Lastly, the roles these differing instruments play in the planning field is examined.

Models

> "Analysis and projection of population are at the base of almost all major planning decisions." (Hightower 1968, p 51)

> "Perhaps the single most important population study for planning purposes in the population projection...for no planning activity is fulfilling its proper function unless plans are developed within a context of a continuum of needs extending from the present to the foreseeable future."
> (Chapin and Kaiser 1979, p 174)

Models encompass a range of approaches that have one thing in common: they specify two or more explicit propositions that share at least one factor or variable (Ascher 1981). Models consist of a set of predetermined relationships which define how these factors will relate together - usually mathematically. The model defines a basic *structure* of variables and their relationship to one another. Their combining of multiple, interconnected propositions (i.e., outputs of one becomes inputs of another, or solutions must satisfy several equations simultaneously) can explicitly express feedback mechanisms, mutual causation, balancing effects, and other complicated dynamics (Oppenheim 1980). An example would be a demographic model of population, where certain characteristics (e.g., birth rate, death rate, migration, etc.) of the population are systematically used to project population forward in time. The model serves as a guide for calculating and managing the various data which together influence the factor being forecast. Once the relationships have been established between the data in question, it becomes simply a matter of making the predetermined calculations to arrive at the factor of interest. If the underlying assumptions in the model are simply taken at face value, we will generate a projection; if the underlying assumptions are critically and systematically assessed as to likelihood, then we will generate a forecast.

Projections versus Forecasts

Demographers make a crucial distinction between a forecast and a projection in terms of their intended use and interpretation. Projections are essentially conditional ("if, then") statements about the future. They are calculations of the numerical consequences (the "then") of the underlying assumptions (the "if"). For example, an analyst might conclude that at the current levels of birth, death and migration (the assumptions) the population will be X at a future time in a given community. What is key here is that the analyst **does not** claim that the rates will continue or that the future population will be X. Rather, he/she simply takes the assumptions at face value, without assessing their likelihood, and goes through the technical exercise generating numbers, which are a projection. It is a hypothetical, technical exercise, and **not a prediction** of what will happen in the future (Klosterman 1990; Isserman 1984a).

Alternatively, a forecast, is an explicitly calculated prediction. It is a statement of what is most likely in the future. Unlike a projection, a forecast evaluates the underlying assumptions - the "if's". They are assessed for their validity, if they are likely to be true or hold in the future: "When the author or the subsequent user of a projection is willing to describe it as indicating the *most likely* population at a given date, then he has [sic]made a forecast" (Shryock, Siegel, and Associates 1975, p 439, italics added).

Given the above distinction, it might seem logical that planners generally rely on forecasts to allocate land, design capital facilities and do other various activities where future population is of concern. After all, planners require a forecast of the number of people expected in given area, not simply a number based on underlying assumptions which have not been evaluated. Still, planners and other social scientists may use projections when forecasts are clearly warranted. This occurs, in part, because generally projections are much easier to generate then forecasts. The numbers usually only have to be input and calculated, without any thought given to the validity of the assumptions inherent in the model. It is quite possible that neither the analyst nor the user has evaluated the assumptions, nor truly believes them to be reasonable. Users may adopt the projection as a forecast without understanding the conditional nature of the exercise, and the need for the assumptions to be evaluated (Klosterman 1990; Keyfitz 1972).

Some authors, such as Isserman, see the need to forecast as being much more than simply a technical issue. In his view, planning needs to go beyond its current problem-solving and pragmatic orientation and re-direct its attention to the future. Planners must think about the long-term future and assume their roles as visionaries and idealists. As Isserman puts it:

> "In this period of self-doubt, the need to forecast and the need to develop new methods of inquiry, new research skills, and new ways of thinking about the future are a refreshing opportunity to begin returning to planning in the true sense, for it should be impossible for a planner to think about what *will be* without thinking about what *can be* and what *ought to be*." (Isserman 1984a, p209)

Planning Applications for Forecasts

Land Use Planning: The land use plan can be defined as "a proposal as to how land should be used as expansion and renewal proceed in the future" (Chapin 1965). Land may be used for commercial, residential, recreational, and industrial purposes. How best to allocate land for these purposes is usually accomplished by combining population forecasts with ratios of space needs per capita. These space needs are determined by how current populations in a given geography are currently allocating land use (usual current practice), how populations in the recent past have allocated land use (recent trends), or standards put forward by professional groups or governmental agencies. Since the ratio of space needs to population is well understood and documented, the ability to plan for the various uses a future population will have for the land can be done successfully, if only future population size can be reasonably known (Chapin & Kaiser 1979).

Capital Facilities Funding: Capital facilities such as sewage treatment plants, electric power plants and transportation systems are characterized by long periods of planning, design, construction and use. Since these facilities are intended to serve future needs, population forecasts are important in determining their capacity and design. In fact, one might be tempted to argue that the population level alone, is the key determinant to adequately designing and subsequently funding capital projects (Tabors 1979). Recognizing the long life of many capital facilities, a growing number of federal agencies have begun to distribute funds either using a formula in which future population to be served is a variable, or committing funds for a specific project with future population being a determinant of the amount awarded (Griffith 1980).

Air Quality Planning: The primary aim of such planning is to identify areas that have the potential to be in violation of any national ambient air quality standards over a predetermined period of time in the future, and to design plans to prevent such violations from occurring. Population forecasts are used in forecasting area-wide emission levels from many kinds of sources. The usual approach is to multiply base year activity times a population growth factor times an emission factor to yield future emissions. This will allow us to gauge future ambient air quality and whether it will be reasonable for future communities.

Outline of this Practicum

This chapter has presented the need for predictions and forecasts in planning, and examined the distinction between projections and forecasts. Chapter two introduces the various methods used by planners and other professionals to forecast socio-economic variables. Different forecast types and their application to planning are illustrated. The chapter concludes by examining the many reasons of why projections, rather than forecasts are often used in many professional circles. Chapter three presents an overview of Canada Mortgage and Housing's Potential Housing Demand Model (PHD Model) and how the model operates. In chapter four, the issue of appraising forecasts is considered. Accuracy as the primary criterion of appraisal is discussed, and past research is presented. The chapter concludes with the study rationale. Chapter five presents the case study analysis of the PHD Model in detail, based on a simulated historical projection. Consistent with past research efforts, the level of accuracy is critically evaluated along with the methodological and underlying theoretical assumptions. Finally, chapter six concludes with a discussion and summary of the findings.

Chapter Two

Forecasting and Projection Methods

Introduction

There are many methods in population projections/forecasts currently in use today. The following section gives a brief overview of the main methods used by analysts. Each can be used to generate projections and forecasts.

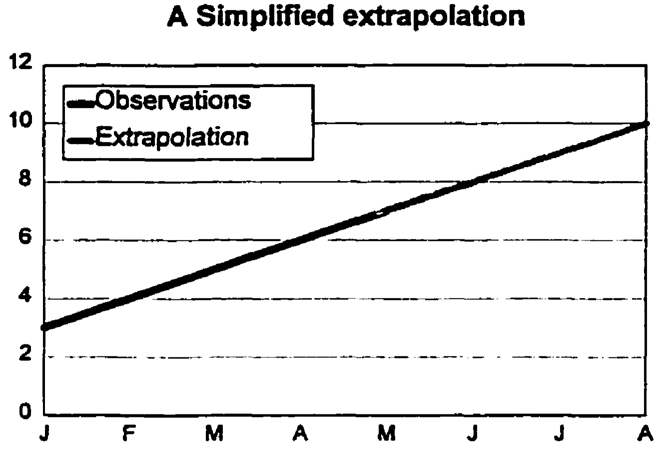
Mathematical trend extrapolation

"Extrapolation is the projection of a historically based quantitative trend at a constant rate" (Oppenheim 1980). Therefore, this method is a search for an equation that describes the variable - in our case population change, over time. Few observations are needed. The essence of the analysis is finding the form of the equation that best fits the data the best. Options include, but are not limited to, straight lines, exponential curves, second-degree polynomials, and other more esoteric forms. These equations imply a statement on the nature of population change. For instance, a linear curve implies a constant amount of change, while an exponential curve implies a constant percentage rate of change. The goal of mathematical extrapolation is to examine the data pattern to find an equation that best fits this form (Pritchett 1981; Pearl & Reed 1920).

An oversimplified example will illustrate the basis of the method. Figure 2.1

projects variable *y* where $y = x+1$ and *x* represents time (a calendar month in this case). In this simple example, variable *y* is projected based on a constant rate of growth that describes the variables' past pattern. This is the essence of the method, quantitatively capturing the past trend of the variable and projecting it into the future.

Figure 2.1



Projection: Once the past pattern of growth has been captured by the equation, the pattern is extrapolated into the future. **The analysis consists of simply identifying the trend and then projecting it into the future.** For example, if an exponential curve with a 3 percent annual growth describes the past well then it is assumed it will continue to grow at that rate in the future.

Although this seems straightforward enough, there are considerations. Foremost, is the question of which years should constitute the historical database. An oversimplified illustration will help clarify. Suppose we have a community with a population starting at 100 in the year 1900. This is followed by a growth period while the area is being settled until 1940. The population swells to 500. Then, from 1940 until

1960 there is out migration, shrinking the population to 400. Finally, there is an increase in population from 1960 until 1990, although not as significant at the first period with the population settling at 600. So we now have three significant trends; the first period of settlement with 500 percent growth, the second with a 20 percent decrease, and the third with a 50 percent increase. Now, the question arises, which trend should be extrapolated into the future? The entire history of the community? The settlement period? The out migration period? The recent growth period?

There is no simple rule to arrive at the decision, although the choice will greatly affect the outcome of the projection. Depending on which period we use (and which associated trend), we will arrive at a different projected population **using the same method.** Using the entire history is not necessarily any better than a given period. There is no right or wrong period to use because they are all conditional. However, one will produce a number closest to the actual population in the future. In trying to determine which projection is closest to the real population, the transition from projection to forecast has begun (Isserman 1984a).

Forecasting: Although, while it is the case that there is no one best history for a projection, the same is probably not true for a forecast. If we consider the historical database and the associated trends within it, we will probably be able to derive some insight into those factors which shaped them. Discovering those factors, we can decide if they may play a role in the future. Put another way, which trends are aberrations and which will continue into the future? Thinking about our previous example, is the settlement growth period of 500 percent going to be representative of the future of this community? Or, is it going to be the decrease of the out migration period? The slow growth as of late? Perhaps the entire historical trend? Probing into these questions, thinking about the past and future, and considering some explanations of what may have happened and what will happen can lead to insights into the historical database. Parts of the historical database may be identified as misleading, while other historical periods may be identified as most relevant to an anticipated future.

Sometimes the extrapolation method is used more freely. If, for instance, the analyst has a particular belief about the future, it is possible to choose the extrapolation model whose projected outcome is considered most likely to happen. The notion that the equation that best fits the past will describe the future is abandoned. Instead, a top-down approach is used whereby the outcome is assessed and the equation form and historical period that produce that most likely future are adopted (Isserman 1984a).

Cohort -Component Method

The essence of the cohort-component method is an accounting framework. Trends summarizing several somewhat different kinds of activity or different types of units can be broken down into separate trends for each, with no theoretical limitation on how fine the disaggregation can be. For example, while population growth was once projected as a unitary phenomenon, now it is projected through fertility and mortality rates applied to different age cohorts for different racial components of the population. The results are then reaggregated to determine the total. The rationale for disaggregation is that each separate, more homogeneous trend will behave in a simpler and therefore more predictable way than the overall trend treated as a single entity. When such disaggregation is employed, the elaborateness of the method comes not only in having to project a larger number of more specific trends, but also in summing them up again. Elaborate models for tracking and combining these components often appear to be, and are promoted as, the most impressive methodological devices for forecasting. In fact, they are little more than highly detailed but theoretically simple accounting mechanisms (Oppenheim 1980).

The effects of future birth, death, and migration rates on population size are traced over time to generate a projected population. The population is divided into groups or cohorts based on age and sex (other additional characteristics are possible, such as ethnicity). As an example, consider a cohort of females age 30. Within that cohort there will be a fixed number of individuals. The number of women in that cohort will change over time by both death and migration. A certain proportion will die in the next year, that is the death rate; alternatively, the proportion who survive form the survival rate. Migration is usually dealt with by the use of a net migration rate (a summation of the net effects of in migration and out migration) as a proportion of the surviving females. Applying these rates over the year, we are left with a new, adjusted amount of individuals for the cohort. Applying these to all age groups or cohorts, we will arrive at a new adjusted population count for any future given year. To determine the number of new births in a given year, the same methodology holds. Each cohort of females has an associated fertility rate (usually defined as births per thousand). Fertility rates vary with age and other characteristics used to define the cohorts, so different rates are used for each cohort. The fertility rate times the average of the number of women in the cohort will give an estimate of the number of births for that cohort. Taken together, an accurate statistical picture of a future population is generated (Shyrock, Siegel & Associates 1975).

The true essence of this model, lies in applying the correct rates to the number of people in each cohort. However, **the model does not produce the rates.** These rates must be input by the analyst. The model is essentially a set of calculations based on the idea that it makes sense to divide the population into groups because birth, death, and migration are known to vary with age, sex and other characteristics. There are no theories inherent in the model for determining the birth, death and migration rates. This is both the model's weakness and strength. There is no way to ascertain future rates for the variables, but at the same time the model clearly shows where the assumptions lie. It is "not that it discloses the secret of what the future holds, but rather that it displays the mechanics of the projection in such a way as to make more evident exactly what is being assumed" (Duncan 1969, p93).

Projection: How the rates are selected and used by the analyst determines whether the model is being used to project or to forecast. For instance, a standard projection approach would be to calculate the current rates and hold them constant into the future. This is a widely used approach. The fact that the rates have not been constant over time, and probably will not be in the future, is acknowledged. Sometimes past changes in the rates are analysed for trends which may be projected into the future. As choices are made in order to arrive at a more likely set of rates, the shift towards a forecast has started (Isserman 1984a).

Forecasting: Forecasting with the cohort-component method requires deciding what the rates will be in the future. After deciding what those future rates will be, they are put into the accounting framework to calculate their implications, i.e., the state of the future population. To decide what those future rates might be, the analyst must ask if the rates will hold constant or will they change in the future? If they are likely to change, then in what way or direction? Are other factors going to influence these rates? What is likely to change between now and the end of the forecast period? The essence of this exercise is to think about the future and to try to understand how it might differ from the recent past. As was the case with mathematical extrapolation, much thought and analysis is necessary outside the formal model itself. With extrapolation, the focus was on the historical period, data points and equation forms. With the cohort-component model, the focus is on choosing the most likely birth, death, and migration rates (Shyrock, Siegel & Associates 1975).

This reflection on the future may lead to certain hypotheses or hunches of expected changes that will be reflected in the model by the adjustment of rates. For example, an analyst might see certain areas of the job market starting to expand in a given community and decide to adjust the migration rate in the future to reflect this fact. The forecaster might decide to increase migration by five per cent each year of the forecast. Now, this approach is not statistically sophisticated by any means, but it is an attempt to forecast rather than simply project, eventhough there is no *precise* mathematical relationship between theorizing about the future community and to the level of rate change. However unsophisticated this forecast might seem, it is still making an attempt to arrive at the most likely future scenario. Moreover, the underlying rationale can be discussed and debated until the most convincing case can be made that the future being predicted is a likely one.

Regression

Regression analysis is the next technique encountered as one moves toward greater complexity among the explicit methods of forecasting. Regression goes beyond accounting mechanisms by embodying actual theoretical propositions and assumptions. Regression has one or more explicit propositions connected by their sharing of at least one factor or variable. The resulting interconnectedness of propositions can, theoretically, capture the complexity of real situations by representing intricate relationships such as mutual causation and feedback. It is the specification of these relationships that distinguishes regression from mathematical trend extrapolation. Surprising implications that may not be apparent by simply looking at a relationship in isolation may be found. Forecasting through regression analysis is basically the prediction of one trend or event based on its relationship with one or more other trends. Usually the presumed relationships are linear (the change in the predicted trend is proportional to the magnitude of change in the other trends on which the prediction is based). One can predict the levels of a variable using standard regression analysis, and can make predictions about events (the probabilities that events will or will not occur) through regression analysis (Oppenheim 1980).

The principal rationale for regression as a forecasting method is that certain trends are primarily determined or conditioned by one or a few other trends. This position does not deny that the real world is more complicated, but rather questions whether it is worth trying to discover and express these complexities, given that the complexities of intricate relationships are often too subtle to be detected in historical data contaminated by many other factors. For example, because energy is largely used to serve individual-level needs of heat, light, and other home uses, and to run the nation's industry, it is not unreasonable to predict energy use as a function of gross national product (which increases along with population, higher disposable incomes for energy-using appliances, greater industrial activity, and so on). If economic growth can be projected, then the trend of energy use can be calculated on the basis of this projection. Certainly, the relationship between economic growth and energy use is in fact more complicated, but not in easily understandable ways. Therefore, regression theory argues that it is best to utilize a straightforward, "robust" linear relationship that expresses the fundamental direction of a trend.

If the trend under examination is presumed to depend on other, more basic trends in a consistent and straightforward way, the following regression equation:

Predicted Variable = Constant A + (Constant B1 * Basic Variable 1) + (Constant B2 *Basic Variable 2) + ...

can be used to predict future values for the predicted variable, by first finding values for the constants, and then plugging values of the basic variables into the equation so that the predicted variable can be calculated. Generally, the task of finding appropriate values for the constants (which in a sense represent how much change in the predicted variable a given magnitude of change in each basic variable would produce or account for), is accomplished in a way similar to fitting the extrapolation line to the actual historical data. The constant chosen is the one that produces the closest fit between the actual and the predicted data points (Oppenheim 1984).

Regression has two vulnerabilities as a forecasting method. The first is that the constants that link the predicted trend to the basic trends reflect the past and present structure of the system. Therefore, if this structure changes, there is no reason to expect that the constants would still represent the relationships among trends. Second, as Oppenheim states, "[regression] validity depends not only on whether the relationships between the predicted trend and each of the basic trends are correct, but also on the projection of each of these basic trends." For example, if you are predicting energy use from gross national product, an underestimate of GNP will yield an underestimate of energy consumption even if the GNP-energy relationship is correctly specified (Oppenheim 1984).

Econometric Models

"Econometric" is defined as economic analysis entailing measurement. Econometric models utilize equations whose constants are estimated on the basis of existing, actual data, much like regression analysis. Once the parameters are estimated, the equations are "simultaneously solved," that is, the values are found for the variables involved that satisfy all of the equations (Johnston 1972).

For example, returning to a projection of energy-use, one might link demand for different fuels (gasoline, diesel, heating oil, coal, etc.) to each of the economic activities (home heating, heavy industry, truck transportation, etc.) that make up total demand. Similarly, a population projection might link age, income levels, race, urban or rural residence factors to those presumably affecting fertility, mortality, and migration rates. This is the essence of econometric modelling: the combining of multiple, interconnected propositions. An explanatory framework is implied where these propositions explicitly express feedback mechanisms, mutual causation, balancing effects, and other complicated dynamics.

While this framework may seem theoretically comprehensive at first glance, like many models, it fails to capture social, political and policy-response factors that cannot be explicitly and quantifiably formulated. It is usually the case that a particular factor is relevant to another factor in intricate ways that cannot be translated into an explicit formulation. Equally, the econometric model assumes that the system and the relationships that it posits are well understood, which remains arguable at best. As Oppenheim (1980, p 80) states, "The act of specifying theoretical relationships in explicit, mathematical form does not establish the correctness of the relationships. Models express assumptions but do not validate them."

This econometric procedure is limited to variables and relationships for which historical data exist. An econometrician would say that this is its strength - it ensures a solid base of experience for the propositions accepted as part of the model. Critics point out that this can also be a limitation, preventing econometric models from incorporating relationships which may be expected to become important in the future, even if existing data cannot speak to what these relationships are likely to be. (Johnston 1972).

Economic -demographic methods

In the economic-demographic approach population change is related to economic conditions. Economic activity is first determined and then population change is based on economic change. There are essentially two techniques in use: recursive models and simultaneous models.

A common recursive approach begins with future employment and derives population using an expected ratio of population in labour-force by age to employment - the *population-employment ratio*. This ratio consists of three important rates related to unemployment, labour force participation, and dependency of total population to the labour-force age population. The processes used to determine these rates and the extrapolation of the population-employment ratio are quite complex and beyond the scope of the present discussion. Needless to say, these are rates with very complex determinants that must be studied by the analyst. The essence of this recursive approach can be thought of as similar to the cohort-component method in that key rates must be used as key inputs into the model (Joun & Conway 1983).

The simultaneous approach is a larger scale model that incorporates both the economic determinants and consequences of population change. Population is linked to economic variables in several ways. Population may be the determinant of the demand for certain goods or services, or of labour force supply. Population might be determined by using a single equation based on previous population and related to a few economic variables such as employment changes, the unemployment rate or perhaps wages. This family of models includes far more factors than those previously discussed. Nevertheless, some variables must still be determined outside the model, such as policy dependent variables (e.g. bank rates), outside forces (export demand), or simply non-economic factors (e.g. death rates). For a projection, the assumption is that these variables will remain constant or follow their historical time trend and the structure of the model will remain constant. That is to say, the ratios and equations built into the model on the basis of a previous time period will also hold true in describing these relationships into the future. However, when forecasting, those assumptions are statements and relationships that must be evaluated. And like the other methods discussed so far, the forecasting process involves thought and analysis outside the model to justify itself (Joun & Conway 1983).

Forecast Types and Planning

Planning requires an idea of the future and forecasts may in part supply that need. Moreover, the interaction between forecasting and planning may happen on many fronts. For instance, the forecast may "fulfill itself". That is, a forecast predicting growth in a particular area or community may enhance further interest and investment as people are attracted to expanding job and goods markets. If public infrastructure is provided in advance of the anticipated growth then the likelihood of private investment is significantly increased (Kunofsky 1977, 1982). On the other hand, if decline is forecasted, private investment is likely to be hampered. Planning decisions will themselves have ramifications on future population change and movement. Whether and where a school is built, a highway extended or a capital facility is built, will all have implications for population change and structure. Perhaps the forecast calls for an undesirable future. Planning objectives might then centre around preventing this "most likely" future from occurring.

This unique interrelationship between planning and forecasting makes certain types of forecast of value to planning. These types of forecast can be describes as pure, normative and contingency forecasts (Isserman 1984a).

Pure Forecasts: This forecast can be described as the most likely future in the absence of major unanticipated public or private initiatives. If this future is deemed desirable, then the planning response may simply be action to facilitate this destiny. If the future is deemed undesirable then the forecast may serve as catalyst for planning initiatives to change it.

Normative Forecasts: A normative forecast is simply the desired future, whatever that may be. The definition of this desired future should evolve from the planning process itself rather than being an utopian or elitist vision. The desired future should be an attainable one. The normative forecast is usually accompanied by a plan stating how this desired future is to be realized, or how the gap between the pure and normative forecast is to be bridged. If the plan is realistic, the normative forecast may become the most likely future.

Contingency Forecasts: These forecasts concern themselves with possible futures, including the highest and lowest plausible population levels (Keyfitz 1972). The emphasis is on the perceived probability of a future scenario occurring. Planning concerns itself with the management of the potential consequences of this future scenario.

Planning responses to contingency forecasts will vary. Sometimes, plans may be created that are flexible enough to deal with the uncertainties generated by the forecast. If circumstances suggest that a plausible population level for a given area might be considerably larger than its most likely level then plans may be designed to accommodate this fact. For instance, a sewage treatment plant may be designed so that enlargement of the facility can easily be done to service an enlarged population if need be. If a set of contingency forecasts suggest too much uncertainty about the future, then planning actions may revolve around trying to reduce this uncertainty. Thus, contingency forecasts may be accompanied by contingency plans. In fact, it is possible to conceive of a set of normative contingency forecasts portraying a desired future, which can be attained under certain circumstances and conditions (Isserman & Fisher 1977).

There is a hierarchical relationship between these forecasts. Baseline projections of current trends or rates provide insight into those factors affecting population change. Pure and contingency forecasts evaluate alternative sets of assumptions by building on the methods and data of the projections. Finally, the normative forecast involves the full planning process to spell out planning and policy actions that will change the population levels forecasted in the previous stage. As Andrew Isserman (as quoted by William Ascher, 1978, p 213) puts it, "From an analytical standpoint the three stages are succeedingly more demanding, but not necessarily more technical. In fact, the set of participating actors broadens with each stage, and the need for non-technical considerations grows. Projections can be prepared by a lone analyst with the requisite technical skills, but normative forecasting will not be dominated by technical specialists in forecasting"

The Widespread Use of Projections

Even though forecasts are often warranted and appropriate, plannners often use projections rather than forecasts. This occurs as a result of the analyst's penchant for using a projection and the user's need for a forecast. Planners and other users are apt to simply treat the projections as if they were forecasts: "The calculation of future population presented as an innocent (indeed tautological) projection by its author, is accepted as a prediction by the reader" (Keyfitz 1972, p 730). Projections are predominantly used in various institutional settings and justification for their use is usually centred on the following reasons.

1. *Demographers do not like to forecast.* Demographers point out that projections do not err (except for technical mistakes, poor data, or errors of computation). If the projected level did not occur, it is because the assumptions did not hold. Since the demographer does not claim the assumptions are set in stone, then he/she cannot be faulted. In the words of an eminent demographer, demographers "protect themselves by calling their work projections. That puts the responsibility for applying them as though they were forecasts where it belongs - with the user" (Keyfitz 1981, p 730)

2. *Many agencies lack even a projection capability.* Many agencies do not have the staff capability of making projections or far less forecasts. They are usually grateful and relieved to obtain any 'future' numbers from a respected source. Therefore, the projection may be accepted and used as a forecast simply because it exists, not because the agency selected it as portraying the most likely future after careful evaluation of several alternative projections. Typically, analysts argue that users do the forecasting, and users believe that they are merely using the analyst's forecast (when the more accurate interpretation would be that they are using the analyst's mere projection) (Engels 1978).

3. *Preparation of projections is safer.* Analysts who project past trends into the future may be blamed for failing to anticipate future changes in the trends. That failure is not likely to damage a career, however, because standard, professional, scientific projection procedures were followed. In constrast, an analyst who forecasts changes in trends and a

most likely future, can be blamed "for going out on a limb, following hunches, or departing from conventional wisdom or established practice" (Wachs 1982, p 564). Therefore, it may seem safer to be more cautious and use a projection for the sake of preserving some professional integrity, even though a true professional would be expected to provide a carefully evaluated, if carefully qualified, forecast.

4. *Projections appear professional and scientific.* Projections appear to be the objective, scientific result of a technical, professional effort. The use of computers, large amounts of data, the use of mathematical computation and ample demographic and economic jargon contribute to this aura. They imbue projections with an authority not merited solely on technical grounds, but of value in the political process.

5. *Projections appear apolitical and not self-serving.* Projections based on the assumption that rates or trends will continue are less likely to be regarded as "political" than are forecasts that incorporate changes in the rates specified by the agency staff. How the rates are changed/adjusted may be considered self-serving and biased by those upset with the forecast. The process usually requires judgemental input which makes it much more difficult to maintain the impression of technically correct, authoritative numbers. When the numbers are used to distribute funds they are likely to be the subject of dispute. It becomes easier to reach a consensus if apparently neutral projections are used, rather than giving any agency the power of making possibly self-serving forecasts. (Pittenger 1980).

6. *Projections can be prepared quickly and mechanically.* If a large number of

jurisdictions are involved, the advantage of a projection over a forecast becomes important. The resources needed to assess the assumptions underlying each forecast may not be available and the result is what Pittenger (1980, p 136) terms a span-of-control problem: "Large numbers of parameters needing judgmental assignments mean that few populations can be forecast by a single analyst...The option would be a large staff generating judgmental forecasts or a small staff making extrapolative projections."

7. *Projections may be the best forecasts.* Statistical arguments exist in favour of projections. Under certain circumstances a projection based on currently observed rates or trends is the best forecast. As Isserman (1984a, p 218) states, "If the analyst has no information regarding the future, is unable to choose among many alternative futures, or considers all possible futures equally likely, and if the expected value of the change in rates based on past data is zero, the projection incorporating no change in rates is the best forecast." It is also possible that, given large confidence intervals within a forecast, a projection would not be statistically different from the forecast. It would therefore, not be worthwhile undertaking the forecasting effort.

These reasons are not to be taken as conclusive evidence for the use of projections over forecasts, but rather to point out that projections are widely selected and used by planners and other agents over forecasts. Since projections are so popular in many circles, the evaluation of their performance and ultimately their worth in planning for future communities is paramount. The aim of this study is to take a step in answering this question.

Chapter Three

CMHC's Potential Housing Demand Model -An Overview

Introduction

CMHC's Potential Housing Demand Model or PHD Model (PHD) was developed for Canada Mortgage and Housing Corporation in 1988 by Tetrad Computer Applications Limited. The model is a cohort-component projection model and its calculations are essentially driven by a sophisticated demographic accounting framework (see Chapter 1). The PHD Model is a demographically-driven model designed to calculate the projected growth in the number of new households formed in a given period of time. New households that are formed will require shelter, which must be found in the housing market. Therefore, new household formation provides the basis for projected demand of new homes in the housing industry. The aim of the model is to project potential demand for new housing arising from net household formation. Projected demand is solely dependent on the projected growth in the number of households.

The model does not project demand arising from non-demographic sources, such as the need to replace units lost through demolition, conversion, and abandonment (net replacement demand), nor does it make allowance for a "normal" level of vacant units.

All projections are produced on a census year basis; i.e., projections refer neither to the beginning nor to the end of a given calendar year, but rather to June 4 of that year. Projected flows cover the twelve month period preceding June 4 of the stated year. The model projects twenty-five years beyond the most recent census year.

Key to the model is the base population of a given community. Knowing the population structure and specific characteristics such as the death or survival rate, births, and migration into and out of the chosen population, allows for a projection of future population growth. Following this projection of the future size of a given population, it is then possible to estimate how many new households will have been created by projecting the same family and housing characteristics that have historically prevailed. To illustrate, the tendency of a family or non-family individual to head a household at a given age, or the headship rate in statistical terms, can be related mathemathically to the projected future population. So too can family proportions and the propensity to rent or buy a home, as well as the type of home people choose to live in. These characteristics of the population in question are derived from the Census and serve as the basis for future potential housing demand when combined with a projected population. The PHD model, like many demographically-based models, can only use current population structure and characteristics and then project them forward. Thus, it is of course limited to the current state in its creation of a future one; it cannot predict changing trends and new emerging attitudes.

Potential versus Actual Demand

The PHD model specifies potential demand, as its title suggests. Actual housing demand in the community, that translates into housing starts activity, can be conceptualized by the following equation:

Actual Demand = (potential demand) + (the need to replace lost units through demolition, conversion or abandonment) - (excess vacant units)

Simply stated, to arrive at actual demand, one must consider the need to replace lost stock minus excess vacant units. Here, 'excess' refers to vacant units above the generally accepted vacancy level of one per cent. Theoretically, these excess units would be taken up before new construction would occur. This distinction between potential demand (based on household growth) and actual demand should be kept in mind, as it will be pertinent when evaluating model performance in chapter five.

The Operation of CMHC's Potential Housing Demand Model

The overall PHD system of models is composed of three main components:

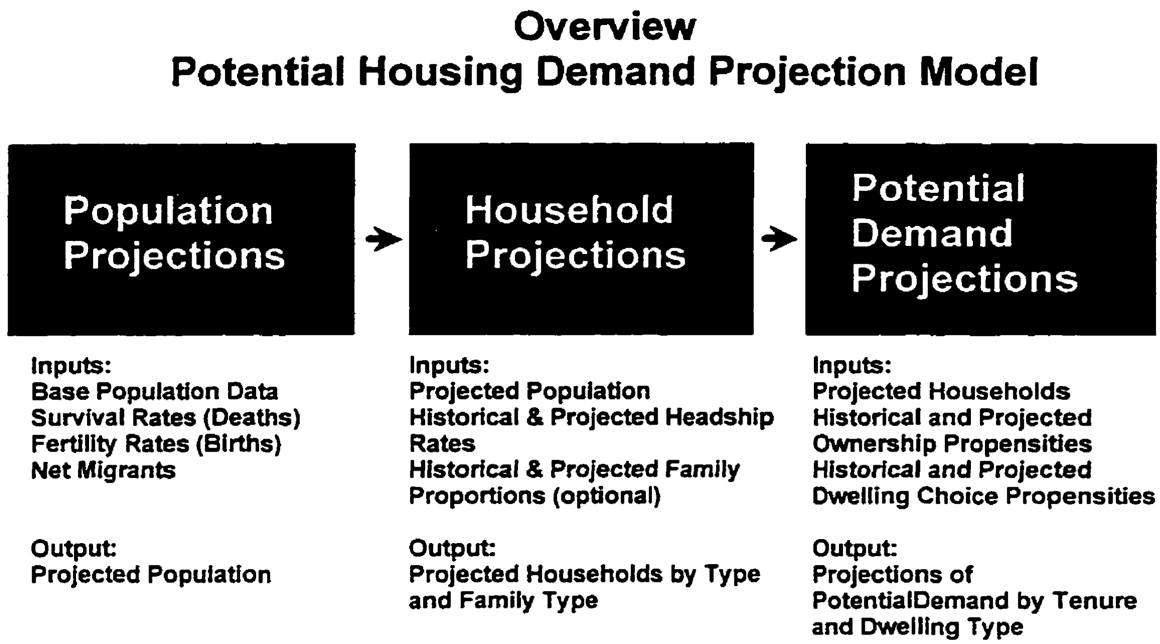
1) A population projection model,

2) A household projection model,

3) A potential housing demand projection model.

Each component provides for the selection (loading) of data from files. Once loaded, some of the data may be manipulated (edited). Results may be viewed on screen, saved on disk or printed.

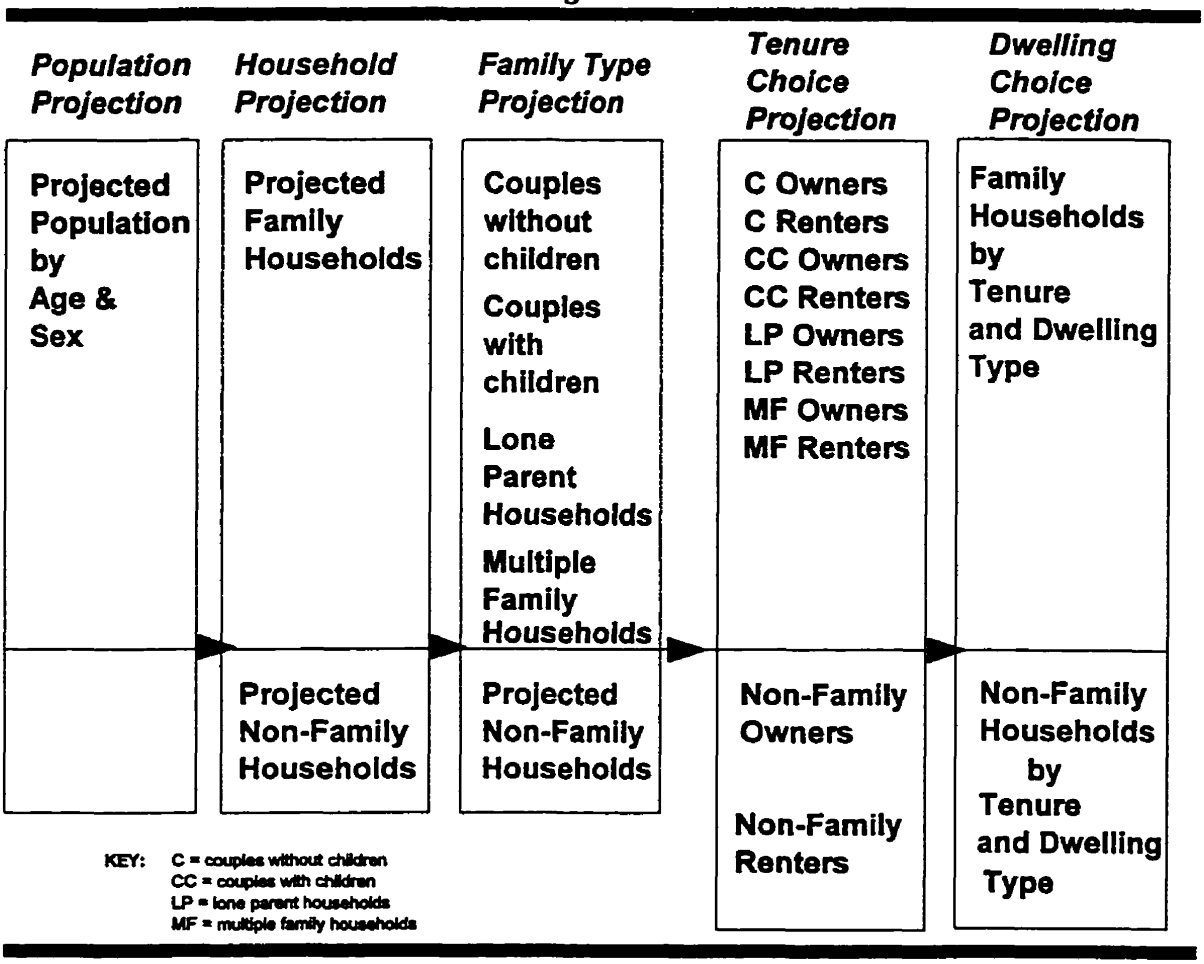
Figure 2.1



Source: Potential Housing Demand Projection Model - User Manual (1993)

Figure 2.1 depicts the basic structure of the overall model. Once the base population is input along with survival and fertility rates, as well as net migration, the projected population can be derived, up to 25 years into the future. This projected population serve as the input for the next main component of the model, household projections. Historical census year family and non-family headship rates will be projected forward on the population generating projected family and non-family households. Projected family households can be further broken down by family type: couples with children, couples

Figure 2.2



Source: Potential Housing Demand Projection Model - User Manual (1993)

without children, lone parents and multiple family households using historical family-type proportions. These detailed family and non-family household projections, in turn, serve as the input for the demand model, providing the basis for tenure projections.

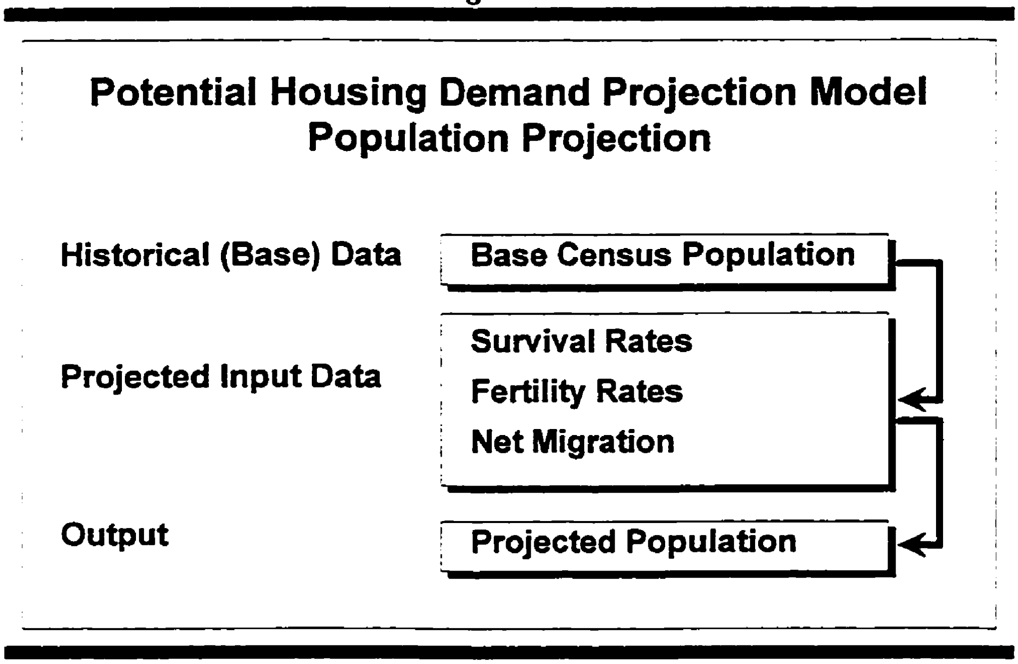
The demand component of the model uses historical census year ownership propensities by household type, as well as historical census year dwelling choice propensities by tenure and household type, to generate the final potential demand by tenure and dwelling type. *Figure 2.2* graphically illustrates the various projections and their sequential flow.

It is important to remember that only population projections and subsequent household projections affect the magnitude of overall demand projected. It is the absolute growth in the number of households projected **-net household formation** -that determines the number of additional dwelling units required to satisfy demographically based demand. Projections of family type proportions, ownership propensities, and dwelling choice propensities affect the tenure and dwelling type composition of projected demand, but not the overall level. Thus, population, particularly net migration, and household projection assumptions (headship rates), are the crucial elements in projecting overall demand.

Population Projection

This component projects population by age and sex. The calculation is based on the most recent census population, which forms the base population for the projection. The base population is adjusted using assumptions about deaths, fertility, and migration to produce

Figure 2.3



Source: Potential Housing Demand Projection Model - User Manual (1993)

a projected population (see figure 2.3). These assumptions may be edited by the user but, once chosen, remain constant over the projection period, except in the case of migration which can be adjusted in any manner over the projection period. The model projects population by single year of age (0-90+, 91 groups) and sex. The basic method consists of multiplying the starting population by age-specific and sex-specific survival rates (determines the number of deaths during the year for each age-sex group) to project the population surviving a given twelve month period. The number of births are then calculated by applying constant fertility rates to female age-group cohorts. The net number of migrants projected for the same period, a total that may be either positive (in-migration) or negative (out-migration) is added to the surviving population to produce the projected population. The model uses a different set of survival rates for each projection year to reflect expected changes in life expectancy. The calculation creates three new tables:

1) Projected Population - by single year of age and sex,

2) Aggregated Projected Population - by five year age group and sex,

3) Components of growth - births, deaths, natural increase, in-migration, out-migration and net migration.

Projected population results are saved for use in the household model.

Population Projection - Summary of Matrix Sizes

A. Fertility Rates - 7 elements

Constant age-specific rates.

B. Survival Rates - 4,600 elements

92 constant rates * 2 sexes * 25 projection years (91 age groups, but two survival rates are needed to project the 90+ group).

C. Projected Net Migration 9,200 elements

2 migration streams (in & out) * 92 groups * 2 sexes * 25 years.

D. Projected Population - 4,550 elements

91 age groups * 2 sexes * 25 years.

Required Historical Data

E. Base (Census) Population Data - 182 elements

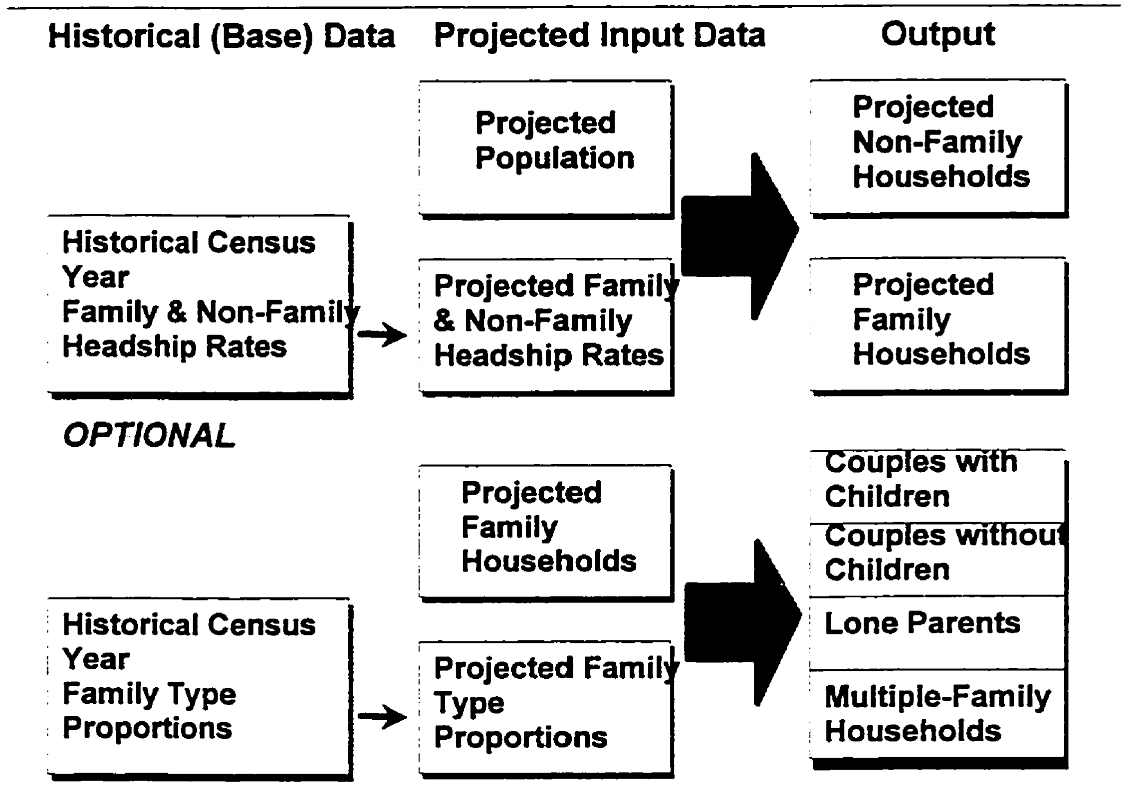
91 age groups * 2 sexes.

Household Projection Model

The Household Projection Model projects family and non-family households separately, thus permitting formulation of different assumptions regarding trends in the formation of each type of household. The model is divided into two parts of which one is optional:

Figure 2.4

Potential Housing Demand Projection Model
Household Projection Flowchart



Source: Potential Housing Demand Projection Model - User Manual (1993)

1) The model projects family and non-family households. Calculations apply projected headship rates to projected population values. Historical family and non-family headship rates can be used or, alternatively, projected headship rates can be inputted directly by the user.

2) Optional. In the second part, family proportions can be used to split projected family households into couples without children, couples with children, lone parents, and multiple-family households. New family proportions may be specified directly, or alternatively, historical proportions can be used.

A headship rate represents the probability that a member of a given age group will head (maintain) a household of a given type (family or non-family). Historical headship rates are the ratio of household heads in an age group to the population of that age group.

Net household formation is computed as the difference in the number of households in successive years. The calculation creates three new tables:

1) Yearly summary of projected households - by household type, total households and average household size by year,

2) Net household formation - by household type and total households, as the difference in the number of households in successive years

3) Net household formation by age group - by household type and total households by 10 year age groups

Household projection results are saved for use in the potential housing demand projection model.

<u>Household Projection - Summary of Matrix Sizes</u>

A. Projected Headship Rates - 650 elements

13 age groups * 2 household types * 25 years

B. Projected Family Proportions - 700 elements

7 age groups * 4 family types * 25 years

Required Historical Data

C. Historical Headship Rates - 130 elements

13 age groups * 2 household types * 5 years

D. Historical Family Proportions - 140 elements

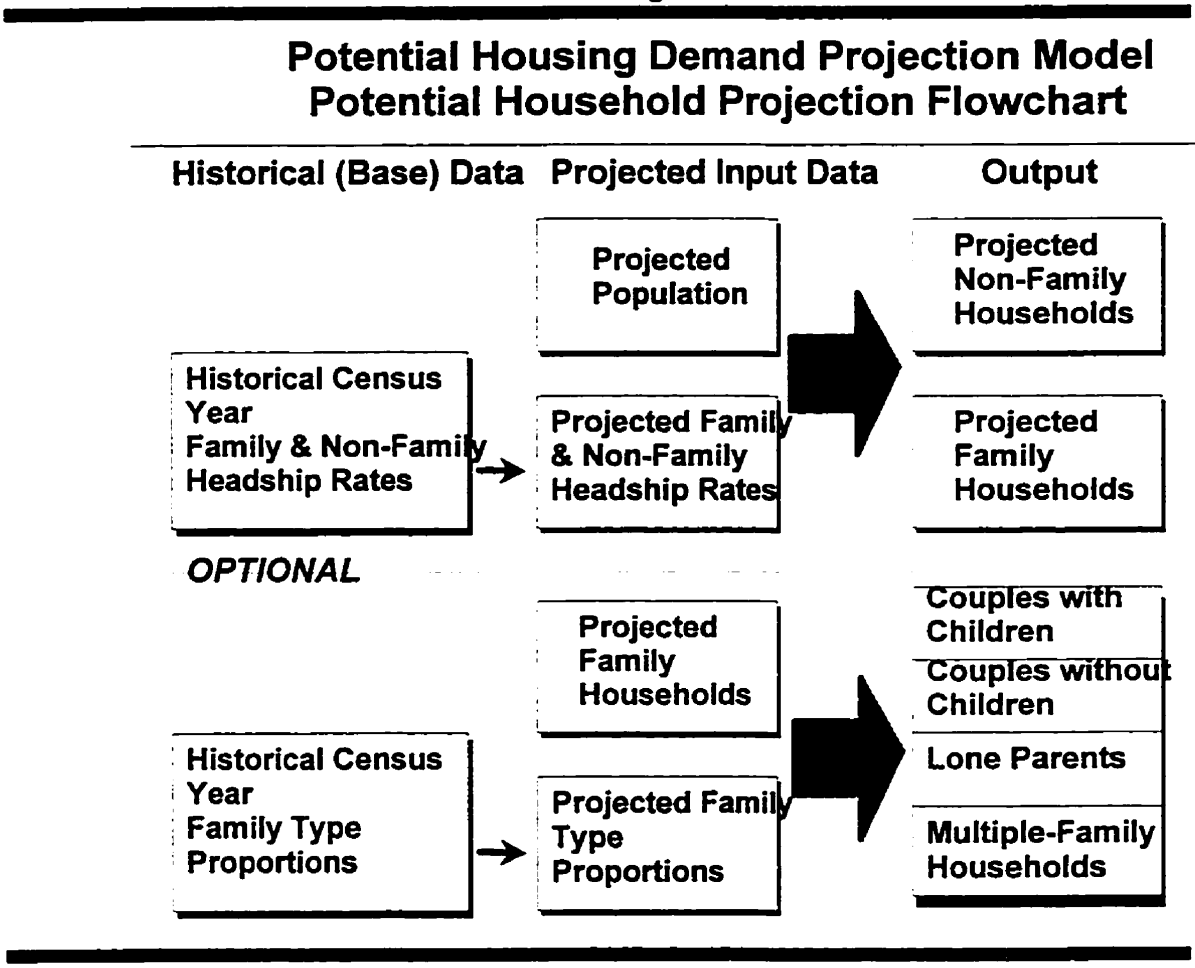
7 age groups * 4 household types * 5 years

Potential Housing Demand Projection Model

The Demand Model is divided into two parts:

1) The model splits projected households into owner and renter groups by applying projected ownership propensities to household projections,

Figure 2.5



Source: Potential Housing Demand Projection Model - User Manual (1993)

2) The model also distributes projected household tenure groups among four dwelling types: single detached homes, apartments, other multiples and moveable dwellings. The calculation applies projected dwelling choice propensities to projected household tenure groups.

Both ownership and dwelling choice propensities may be based on historical data or specified directly by the user.

Potential demand is computed as the difference in occupancy by tenure and dwelling type in successive years. The calculation creates four new tables:

1) Projected Tenure Choice - by household type and ten year age group,

2) Projected Dwelling Choice - by tenure, household type and age group

3) Aggregated Projected Dwelling Choice - by tenure and household type,

4) Potential Demand - by tenure and household type and as the difference in occupancy in successive years.

Demand Projection - Summary of Matrix Sizes

A. Projected Ownership Propensities - 1,750 elements

7 age groups * 5 household types * 2 tenure choice * 25 years

The five household types include non-family households and the four types of family households.

If tenure choice is projected for non-family and family households (i.e. not by detailed family type), the size of the matrix shrinks to 700 elements (7 age groups * 2 household types * 2 tenure choices * 25 years)

B. Projected Dwelling Choice Propensities - 1200 elements

3 age groups * 2 household types * 2 tenure choices * 4 dwelling types * 25 years

<u>Required Historical Data</u>

C. Historical Ownership Propensities - 420 elements

7 age groups * 6 household types * 2 tenure choices * 5 years

The six household types include non-family households, total family households, and the four family household types.

D. Historical Dwelling Choice Propensities - 240 elements

4 dwelling types * 3 age groups * 2 household types * 2 tenure types * 5 years

Summary

CMHC's PHD Model is a cohort-component model using a demographic accounting framework to calculate net household growth which is synonymous with potential housing demand. The model comprises three main components. The population projection is calculated first and serves as input for the household projection component. Similarly, the household projection model output serves as input for the potential housing demand component. The final output is projections of potential housing demand by tenure and dwelling type.

Major Strengths and Weaknesses of CMHC's Potential Housing Demand Model	
Strengths	***Weaknesses***
Performs numerous calculations extremely quickly, freeing the analyst from this tedious task.	Requires numerous detailed data sets to perform the projections.
Provides detailed output / projections.	Requires some knowledge in demographics and housing characteristics to interpret and judge the output / projections.
Once the parameters of the model are understood, the core assumptions inherent in the projection are apparent.	Changing projected trends from beyond the base year requires in-depth knowledge of demographics and housing characteristics and their interaction. This will be beyond the scope of most users.

Major Strengths and Weaknesses of CMHC's Potential Housing Demand Model	
Strengths	***Weaknesses***
Allows for trend projections within the forecast horizon on headship rates, family proportions, ownership propensities and dwelling choice propensities.	Fertility can be projected from the base value and year only. No trend projection of fertility is possible
Is a theoretically complete demographic accounting system that accounts for potential housing demand (i.e., output from one component of the model serves as input for the next component.)	Trends established in one component of the model (either by the base data itself or by the analyst at their own discretion) will be passed on to other components within the model that are dependent on it. Therefore, the final projection of potential housing demand becomes sensitive to trend assumptions and projections earlier in the model.

Chapter Four

Methods of Projection/Forecast Appraisal

Introduction

As discussed in Chapter one, the use of projections in planning and in the social sciences generally is widespread. Therefore, the question of their merit, especially vis-a-vis forecasts is significant. Although this is true, "there are few available studies of the accuracy of population projection methods," (Smith 1987, p 189). Nevertheless, there have been relatively recent attempts to study this question by researchers such as William Ascher, Andrew Isserman, Norbert Oppenheim and Micheal Stoto.

These researchers generally agree that complex models have unique properties as not just projecting but forecasting tools. Multiple, interconnected propositions (outputs of one become inputs of another, or solutions must satisfy several propositions or equations simultaneously) can explicitly and systematically express mutual causation, feedback phenomena, and other intricate relationships. The question is whether these properties can be harnessed to improve prediction and explanation. As Oppenheim (1980, p 96) states, "To some extent, this potential can be revealed by the performance of a model. In addition, we may also consider the logical and structural properties of complex models and evaluate those properties with respect to the task of forecasting."

Although the appraisal of a forecast performance is clearly warranted, there are many performance criteria that could be considered relevant. Thus appraisal is difficult. The choice of appraisal standards is difficult because there are multiple, and sometimes contradictory, goals of forecast formulation and use. For example, perhaps the goal is one of technical sophistication, whereby methodological elegance is an important criterion. Or perhaps it is one of sensitizing policy makers to future opportunities or dangers, in hopes of enhancing the decision making process, whereby accuracy of the forecast is not the chief concern. The goals of forecasting will vary according to the actors in the process and their particular perspectives. Therefore, it is critical to identify the contextual goals of forecasting, to arrive at relevant, appropriate performance criteria.

From a policy maker's perspective, the primary utility of the forecast lies in its comprehensiveness and comprehensibility and, most importantly, in its accuracy. When a policy or decision is formulated, the contribution of the forecast lies in its credibility and authoritativeness. The forecast serves as "intelligence" for the policy analyst. As an information source, it is quite obvious that accuracy is paramount. Although there are many possible criteria to consider when judging forecasts, from the perspective of informing the decision making process, accuracy remains critical (Ascher 1975).

Accuracy as the primary criterion of appraisal

Since accuracy is only one possible measure of performance for forecasting, why choose it over other criteria? Indeed, critics would point out that forecast accuracy is an incomplete appraisal of its worth and consequences. This seems true enough, but the real question becomes one of asking whether other criteria can be applied to the appraisal of forecasts. In considering the general performance of forecasting, the accuracy criterion must be emphasized since the potential for reaching a general conclusion regarding other criteria is very limited (Ascher 1979). These limitations involve both problems of measurement and problems establishing what factors or methods lead to "good" forecasts.

Problems of measurement simply point to the fact that other relevant characteristics of forecasts - comprehensibility, persuasiveness, usefulness, authoritativeness, provocativeness, importance, etc., pertain to the unmeasurable or unobserved impacts of the forecast on an audience. The impact of a forecast cannot be ascertained without exhaustive consideration of the context within which it was made. This is much less true of a forecast's accuracy, which can be calculated more or less independently of the context in which it is made. Equally, the importance of forecasts in a given decision-making process is difficult to estimate, as policy makers are exposed to numerous sources and pieces of information that influence them in various and complex ways. Not only is there the problem of determining how much conscious attention is paid to forecasts, but there is also the problem of determining whether, or to what extent, forecasts are discounted if they clash with the policy analyst's intuitive beliefs about the future, or about what proper policy should be regardless of what the forecasts implies for the validity of such policy. These difficulties apply to appraising all aspects of a forecasts impact.

The use of accuracy as the main criterion for appraising forecasts can be strongly defended directly from the policy making perspective. In terms of rational planning, planners adopting this paradigm would generally agree accuracy improves decision-making capability (Ascher & Overholt 1983). In fact, accuracy for its own sake, is *a priori* useful for rational decision-making. Forecasters themselves view accuracy as an asset because the utilization of forecasts requires, at a minimum, credibility. No forecast could be considered worthwhile, if it is not perceived as credible and thus persuasive (Ascher & Overholt 1983).

The above noted considerations provide a strong case for the use of the accuracy criterion and can be summed up as follows:

1) There are numerous possible criteria by which a forecast can be legitimately appraised.

2) Accuracy is one of the major criteria to appraise forecasts.

3) Other criteria are characterized by being heavily context and audience dependent. Therefore, these criteria are inherently more difficult to study objectively.

4) Forecasters and policy makers consider accuracy paramount to forecast usefulness.

5) Accuracy is the only major criterion that can be applied to many forecasts, and for which general propositions about the impact of various factors on forecast performance can be made.

Theoretical Coherence as a Correlate of Accuracy

The challenge of evaluating the accuracy of specific forecasts requires some means of identifying and testing the relevance of various characteristics of the forecast formulation. But which characteristics? Almost all researchers have adopted an empirical approach that considers relevant factors such as the basic scientific information and techniques at the forecaster's disposal. The accuracy of the forecast is evaluated in terms of its theoretical coherence, which includes such elements as its logical consistency, the plausibility of its assumptions, the validity of its techniques for that specific application, adequacy of the data, the biases likely to stem form the formal characteristics of the techniques, and the context of the trends themselves, etc (Ascher 1979; Oppenheim 1980). This approach limits the relevant factors to what a practising forecaster is likely to emphasize, i.e., characteristics of techniques and aspects of the context pertaining to the trends *rather than to the forecasting process itself.*

The empirical approach provides numerous potential correlates of accuracy or plausible connections between accuracy and the characteristics of a formal forecasting technique. In practice, these connections may or may not be relevant. They fall into two major groups: relevance of methodology and relevance of context.

Relevance of Methodology

The connection between methodology and accuracy should be examined. Is the methodology sound in terms of technical considerations for producing an accurate forecast? What are the pitfalls in method that hamper or increase accuracy? Does the method make clear what assumptions are being made? The present evaluation of methodological considerations touches upon four key areas:

1) Adequacy of data;

Does the data adequately describe the trend in question? Are there inconsistencies, gaps, outliers or other miscellaneous anomalies that could affect forecast outcome?

2) The *a priori* validity of the assumptions;

Are the assumptions inherent in the model valid for the forecast? Can they be identified and evaluated for impacts upon the forecast? How might these assumptions affect the robustness of the forecast?

3) Potential biases that may stem from the formal characteristics of the techniques

Do the forecasting techniques have built-in biases stemming from inherent characteristics? Can they be identified and dealt with? How will these biases affect forecast accuracy?

4) The context within which the trend(s) occur(s)

What is the history of the trend? What is its stability and variability? Perhaps the nature of the phenomena underlying the trend may be relevant.

Relevance of Context

The importance of contextual factors to the overall accuracy of forecasts and to the comparative advantages of various methods must be considered. Do some factors make the basic projection task inherently more difficult? To what extent is the context at that moment more amenable to prediction by one method than by another? Three main contextual factors may be examined (Ascher 1979).

1) Remoteness of the target date

A forecast must account for the characteristics of a trend from the date the forecast is made to the target date. The longer the forecast period, the greater the chances that conditions affecting the trend may change. Put another way, the certainty of prevailing conditions declines as the length of the forecast period increases. Therefore, the more remote forecasts are intrinsically more difficult and, in general, will be made with less accuracy.

2) Structural stability

Trends unfold in a "structure" that is characterized by the relationships of the trend to other factors. At any point in time, the structure links the trend to factors that "cause" it, and hence can explain it. Therefore, an accurate characterization of the structure can account for and predict the trend. The real problem is that structures are not necessarily stable. As the structure changes, the former relationships that allowed prediction may not hold true. One activity may still influence another but to a lesser or greater extent. Thus, structural instability would presumably result in less certainty and accuracy for any forecast, regardless of the method employed. Therefore, knowing the level of stability might help to estimate the likely accuracy of available forecasts.

3) Complexity of the context

Trends can be thought of as a "configuration" of factors that are complex and interactive. To the extent that other conditions and trends impinge upon the forecasted trend, it is more difficult to accurately specify the state or equilibrium of conditions and trends that will prevail at any future moment. So, if the context of a trend is complex (in the sense that many different factors have some bearing on its development) the task of taking into account all relevant variables becomes much more difficult and therefore, the forecast's accuracy becomes more problematic.

In summary, the evaluation of forecast accuracy appears to lie in consideration of the following:

1) Logical consistency;

2) Plausibility of assumptions;

3) Validity of techniques.

Generally, investigators such as Ascher, Isserman and Oppenheim have evaluated projections in terms of the correctness of their underlying theoretical assumptions as outlined above, and also in terms of how close the predicted levels come to actual levels. Both are important. Inadequacies of theoretical assumptions, if recognized by potential users, may endanger the plausibility and hence the use of the projections. Inaccuracy detracts from the actual policy-making utility of the projection. Once the accuracy of a projection has been determined, it constitutes a basic indication of the projection's validity. Researchers such as William Ascher, Andrew Isserman and Norbert Oppenheim have expressed projection inaccuracy as the percentage of error of a prediction made in year X for the target $X + t$:

actual population in year $X + t$ - predicted population in year $X + t$ / actual population in year $X + t$

Allowing t to equal five, ten, twenty or twenty-five years, will enable the projection to be compared for different time horizons.

Past Research

> "The record of forecasting in general reveals much about the nature of forecasting and the nature of the world that the forecasts address. In addition, we may also consider the logical and structural properties of complex models and evaluate those properties with respect to the task of forecasting." (Oppenheim 1980, p 96)

The ASA-NBER Survey

The American Statistical Association and the National Bureau of Economic Research (ASA-NBER) sponsored an on-going survey that evaluates econometric models for short-term (four to six quarters) forecasting. The method of evaluation consisted of comparing the level of error on a mean percentage basis for forecasts produced between 1968 and

1973 for the target years of 1974 to 1978 and the actual recorded level for quarterly and annual GNP changes.

The ASA-NBER survey indicates that econometric models have not, and still do not, forecast quite as well as a judgmental approach relying on no explicit routines. A comparison of a number of economic forecasting sources that considered forecasts produced from 1968 through 1973 discovered judgmental forecasting efforts slightly outperformed econometric approaches for quarterly GNP, and were roughly even in forecasting annual GNP changes (Su & Su 1975).

Victor Zarnowitz compared annual forecasts of real GNP and the inflation rate by two econometric modelling operations - the Wharton and the University of Michigan models and two non-econometric sources, for the period of 1969-76. He concluded neither method was superior to the other (Zarnowitz 1978).

Stephen McNees considered annual forecasting for the 1961-76 period and found the same two non-econometric sources to be roughly equal in accuracy to several econometric operations - Chase Econometrics and DRI in addition to the Wharton and Michigan models (McNees 1976).

Andrew Isserman conducted an analysis of population projections for subcounty areas. The objective of the research was to document the level of accuracy of a number of commonly used extrapolative methods. Various extrapolation methods were used to simulate ten-year population projections for townships in Illinois and Indiana. Census data from 1930 to 1950 were used to project 1960 populations, and data from 1930 to

1960 were also used to project 1970 populations. These projections were then compared to the actual 1960 and 1970 census counts in order to estimate their mean percentage errors as a measure of their accuracy.

Extrapolative methods have been criticized for their weak theoretical foundations, yet remain popular as a planning tool due to constraints of data, time, funds and expertise. More than 35 hundred simulated population projections for 1960 and 1970 were made for most of the methods being tested. The simulated projections were then compared to the actual populations to measure percentage errors and tendencies to over- or under-estimate. The results indicated that extrapolative methods may yield sufficiently accurate projections for many planning purposes (Isserman & Fisher 1977).

Finally, a large retrospective appraisal of the forecasting record was conducted by William Ascher (1979). The forecasting record consisted of the following:

- US trends in population
- Energy demand (consumption of petroleum, electricity, and total energy)
- Transportation (airline passenger volume, general aviation fleet size, motor vehicle registrations)
- Economic growth (real and nominal GNP Change)
- Technology (computer capability and nuclear energy capacity)

Ascher's appraisal consisted of comparing the predicted output in a given year to the actual record. Ascher expressed the inaccuracy of the forecasts as the percentage of error of a prediction made in year X for the target year, as compared to the actual value in the target year.

The investigation revealed three general findings consistent with the other previously cited studies:

1. ***Methodological sophistication contributes very little to the accuracy of forecast***; For instance, the introduction of more sophisticated methods in population forecasting, with the elaborate accounting divisions of components and cohorts, has not resulted in more accurate demographic forecasts.

2. ***A forecast time horizon is the strongest and most consistent correlate of its accuracy***; Though there are some exceptions, the general rule is that the shorter forecasts are more accurate, often in a nearly linear relationship.

3. ***Past research points to the essential importance of the validity of core assumptions antecedent to the choice and application of methods.*** Behind any forecast, regardless of the method, are core assumptions that define the context within which the specific trend develops. These assumptions must remain valid for forecast accuracy, no matter what method of forecasting is used.

Study Rationale

As stated in Chapter 2, the Potential Housing Demand model is a cohort-component model and its calculations are essentially driven by a sophisticated demographic accounting framework. Certain assumptions in the model are manipulable by the user (e.g., migration rates, headship rates) to allow for judgemental considerations when creating projections. The model allows for trend considerations on the part of an analyst so that he\she may move toward a forecast of housing demand, rather than just a projection. While this avenue of approach is open to the user of the model, most users will accept that past trends are a good baseline indicator of the future and will want to know what future housing demand will be given the most current information. Also, in consideration of the complexity and elaborateness of the model, it is not readily apparent which trends may be susceptible to change and by what factor. *Considering that most users will inevitably utilize a straight forward projection as a baseline approach which will form the nucleus of future deliberations, the present study is aimed at evaluating the legitimacy of this projection. The investigation revolves around the "pure" model, i.e. the mechanical operation of the model insulated from judgement.* As Oppenheim (1980, p 100) states... "the projection indicated as the most likely may be considered as if it were the unconditional forecast nestled among other conceivable but less likely possibilities. This most likely projection may then be evaluated like a standard unconditional forecast: retrospectively, by measuring the discrepancy of predicted trend from actual trend."

Objectives

There are two objectives to this research:

1. To appraise the performance of the Potential Housing Demand Model in a manner consistent with past research.

2. To determine the performance of the PHD model with respect to the following two general findings of past research:

A) *A forecast time horizon is the strongest and most consistent correlate of its accuracy.*

B) *The essential importance of the validity of the core assumptions.*

Method

A case study analysis of the PHD model has been conducted, consisting of the following:

1. A historical projection simulation from 1971 to 1996.

2. An evaluation of the projection based on accuracy, in terms of:

A) Theoretical assumptions/coherence

B) A measure of the discrepancy of predicted data/trend from actual data/trend.

Unique Issues

Rather than using an historically made projection, historical data was input into the model to run a simulation of an historical projection. This approach is not entirely consistent with a true historical projection, since the migration scenario for the population projection was input from the actual Statistics Canada record. This allowed for a more accurate appraisal of the model, since normally the migration scenario would be estimated.

Other Considerations

Simulation also allows for another very important consideration. Namely, that the forecast is subject to amendment or a change in the parameters of the projection as a means of investigation. That is, certain factors or parameters of the model can be modified, and then projected once more, if the investigator wishes to explore certain facets and assumptions inherent in the model and how they may affect model accuracy. Many "runs" of the model under slightly different assumptions are possible as a means to gauge model accuracy. While this avenue of research is possible, this investigator has limited the scope to one projection in view of time and resource constraints. However, this method opens the possibility for other investigators to build on this research effort, and to continue investigating the assumptions, factors or parameters within the PHD model.

Chapter Five

A Case Study Analysis of the PHD Model

A historical forecast and its level of accuracy

The evaluation of model accuracy is divided into three main categories that correspond to the divisions within the model itself. The first section deals with components of growth or the population projection. The second area deals with household growth which is synonymous with household demand. The third section concerns itself with dwelling choice propensities - specifically, the demand for single-detached homes and multiple-unit dwellings.

I Population Model - Components of Growth

The population model is composed of four essential demographic characteristics. Those used in the simulation are indicated in parentheses.

1) Base population: this is the population structure in a given jurisdiction by one year cohorts that is projected forward into the 25 year forecast period (Saskatchewan 1971 base population - Statistics Canada, Cansim Time Series).

2) Survival: this is the incidence of age-specific survival rates among one year cohorts to statistically define the surviving population (Saskatchewan 1986 Survival rates, Statistics Canada).

3) Fertility: statistically describes the incidence of human reproduction among child-bearing females in their reproductive years (Saskatchewan 1971 Fertility rates, Statistics Canada).

4) Net migration: denotes how many persons have left or come into the jurisdiction in question (Saskatchewan Net migration record from 1971-1996, Statistics Canada).

Population Projection Method

The model projects population by single year of age (0-90+ , total 91 groups) and sex. The basic method consists of multiplying the starting population by age-specific and sex-specific survival rates to project the population surviving a given twelve month period, and then adding in the net number of migrants projected for the same period, the total of which may be either positive (in-migration) or negative (out-migration)

Population Results

Figure 4.1 illustrates the PHD population projection against the actual record from three authoritative sources (see Table 4.1 for detailed numerical output). As can be readily seen by the graph in Figure 4.1, the PHD projection demonstrates higher population

Figure 4.1

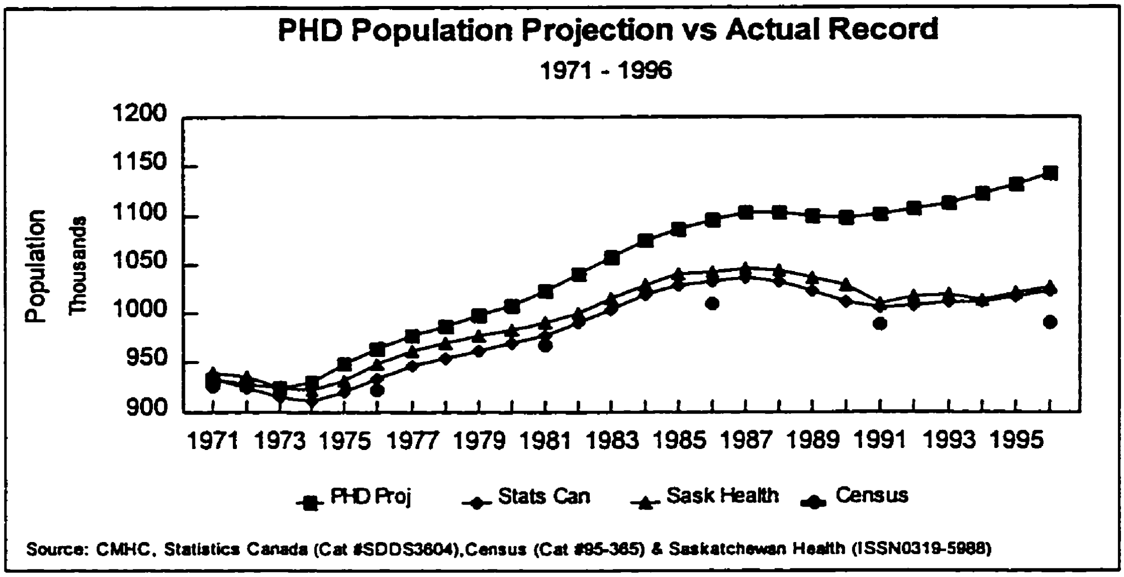


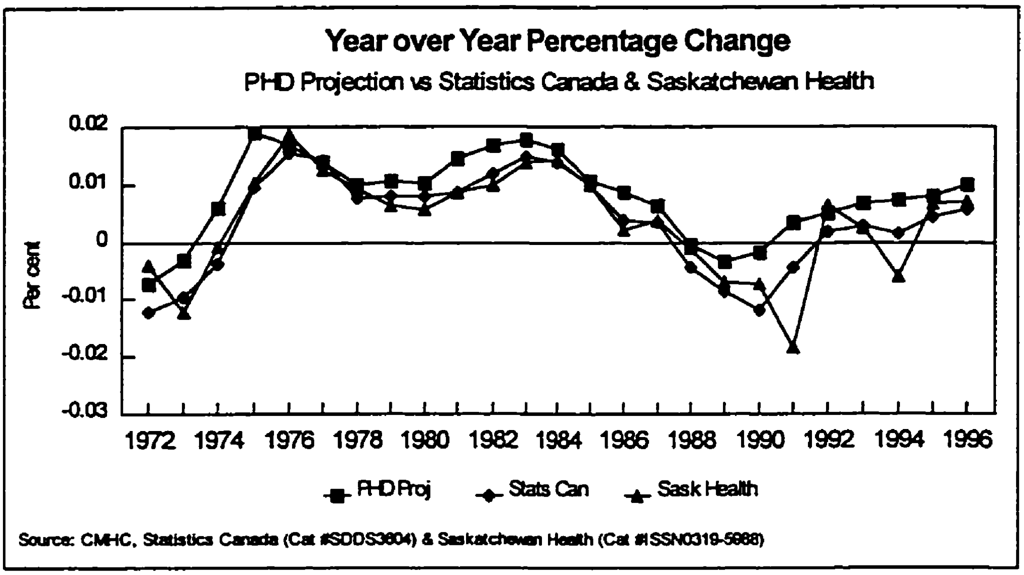
Table 4.1

Detailed PHD Population Projection vs Actual Record

1971 - 1996

Year	PHD Population	Per cent Change	Population Stats Can	Per cent Change	Population Sask Health	Per cent Change
1971	934402		934402		938527	
1972	927467	-0.74%	923106	-1.21%	934607	-0.42%
1973	924521	-0.32%	914223	-0.96%	923181	-1.22%
1974	930175	0.61%	910703	-0.39%	922487	-0.08%
1975	947811	1.90%	919621	0.98%	931921	1.02%
1976	963699	1.68%	933795	1.54%	949463	1.88%
1977	977016	1.38%	947019	1.42%	961526	1.27%
1978	986906	1.01%	954177	0.76%	970510	0.93%
1979	997502	1.07%	961819	0.80%	976734	0.64%
1980	1007762	1.03%	969662	0.82%	982257	0.57%
1981	1022310	1.44%	978204	0.88%	990746	0.86%
1982	1039584	1.69%	989856	1.19%	1000667	1.00%
1983	1058040	1.78%	1004715	1.50%	1014496	1.38%
1984	1075082	1.61%	1018601	1.38%	1028965	1.43%
1985	1086591	1.07%	1028841	1.01%	1039249	1.00%
1986	1095983	0.86%	1032879	0.39%	1041358	0.20%
1987	1103078	0.65%	1036432	0.34%	1045440	0.39%
1988	1102411	-0.06%	1031717	-0.45%	1044151	-0.12%
1989	1098681	-0.34%	1022954	-0.85%	1036862	-0.70%
1990	1096699	-0.18%	1010825	-1.19%	1029352	-0.72%
1991	1100318	0.33%	1006314	-0.45%	1010526	-1.83%
1992	1105976	0.51%	1008004	0.17%	1016944	0.64%
1993	1113354	0.67%	1010807	0.28%	1019566	0.26%
1994	1121601	0.74%	1012156	0.13%	1013584	-0.59%
1995	1130760	0.82%	1016600	0.44%	1020378	0.67%
1996	1142016	1.00%	1022537	0.58%	1027551	0.70%

Figure 4.2



values than all three other sources. Even as early as the next census in 1976 the population is 3.2 per cent higher than the Cansim time series, and 1.5 per cent higher than the population record from Saskatchewan Health. By the end of the forecast period in 1996, the PHD projected population is 11.7 per cent higher than the Cansim time series, and 11.1 per cent higher than the Saskatchewan Health data. In raw terms, this amounts to 119,500 persons in the case of Cansim, and 114,500 in the case of Saskatchewan Health. If these additional people were taken into account for the creation of future housing it would imply about 40,000 additional households above the true population (average household size of 2.88). This amounts to a sizable discrepancy between actual population values and the PHD projected amount. Figure 4.2 illustrates year over year percentage changes in the three streams. It is quite apparent that the PHD projection is consistently postulating higher per cent increases than the other two sources. Even when negative population growth is experienced, the PHD projection accounts for a smaller roll back than the other two. The Saskatchewan Health data should be considered the most accurate record of population since yearly collected information is synthesized and published. This data source is considered the most reliable as births, deaths and transients are all captured as they actually occur within a maximum six month period.

Births

Figure 4.3

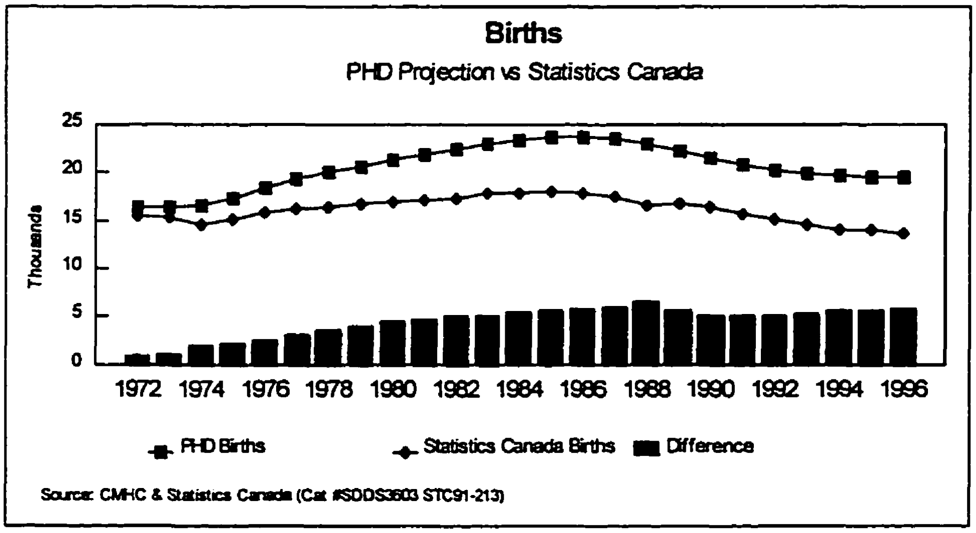


Figure 4.3 illustrates PHD projected births against the Statistics Canada record. Right from the beginning, the PHD projection overestimated the birth record. This is surprising since the 1971 fertility rate should have yielded a reasonable approximation of births early in the forecast period. The growing discrepancy can clearly be attributed to a

Table 4.2

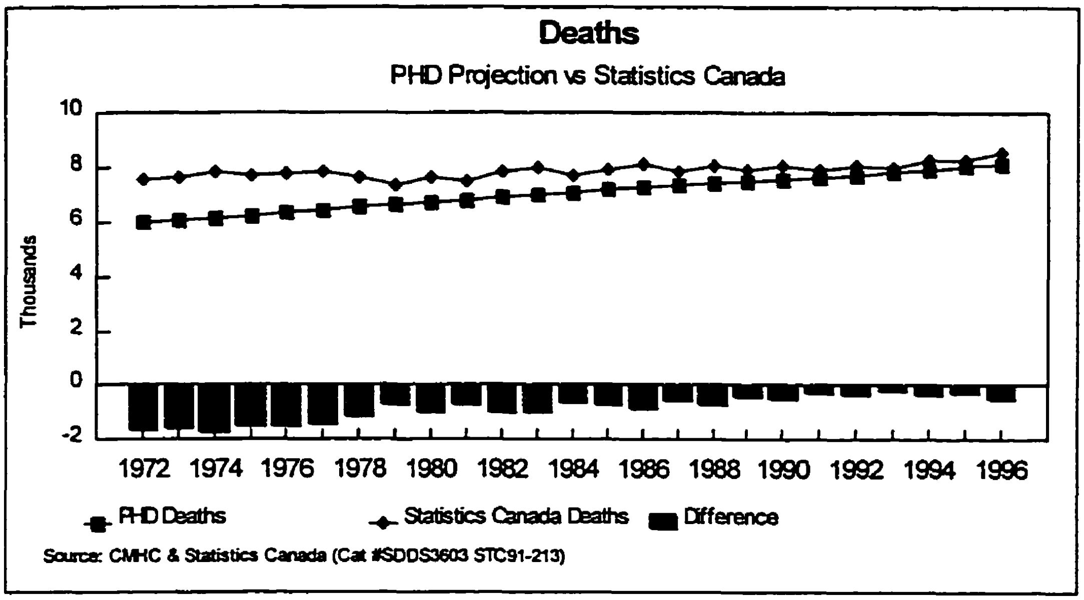
Fertility Rates per 1,000 Women by Age Groups
Saskatchewan

Year	15-19	20-24	25-29	30-34	35-39	40-44	45-49
1971	51.1	173.7	165.7	89.4	42.8	13.7	1.2
1996	45.4	110.4	140.1	84.6	24.6	3.7	0.1

Source: Statistics Canada

diminishing fertility rate from 1971 to 1996. Births per 1,000 women in childbearing years dropped considerably in the 25 year forecast period as Table 4.2 illustrates. Since the forecast assumes a flat rate of fertility, while in reality the fertility rate is diminishing, the outcome will inevitably be an overestimation of births over the forecast period. One can safely assume an analyst should account for this trend by considering the past behaviour of the variable and projecting a diminishing fertility rate over the forecast period. While this may be true, the PHD model does not allow a change in input for this variable (apart from the base year). This is an odd oversight given that the model allows most other variables of interest (e.g. headship rates, family proportions, dwelling choice propensities) to be changed along any given year of the forecast period. Perhaps the original creators of the model felt that this parameter would not likely change much nor substantially affect the output of the model. In any case, this remains an identified weakness in the model, based on the present research.

Figure 4.4



Deaths

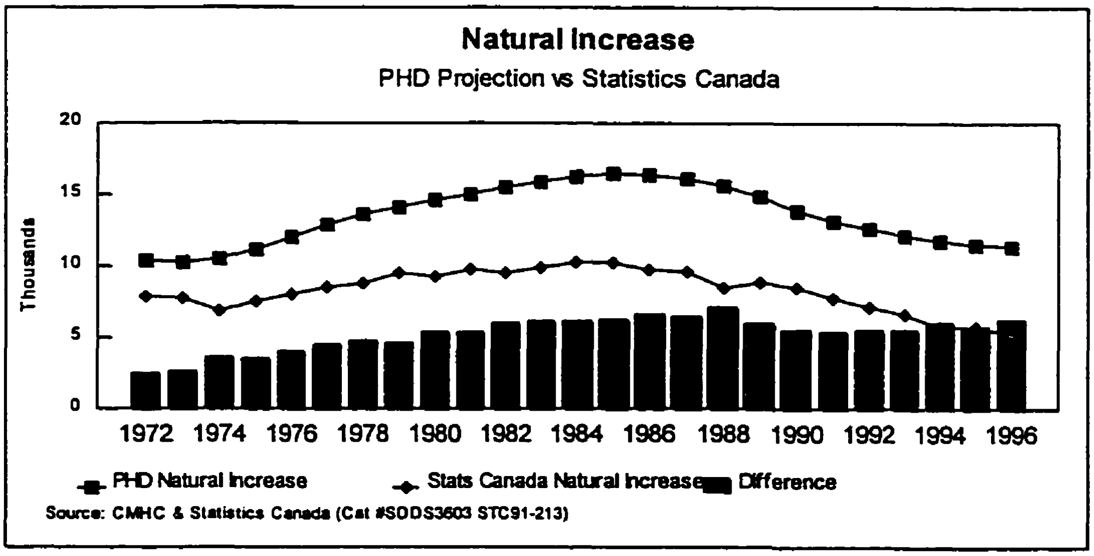
While births were overestimated in the model, deaths were underestimated. Considering that the overall population level is higher in the PHD projection as opposed to the Cansim time series, deaths should be higher on that account alone. Rather, the estimation of deaths at the beginning of the forecast period is about 1,600 deaths short, which gradually increases to a deficit of about 400 deaths. Rather than the prediction becoming more accurate, the narrowing of the gap can be attributed to the overestimation of births in the PHD model leading to higher absolute deaths levels as the forecast period is extended.

Therefore, the PHD model is simply underestimating deaths equally, all along the forecast period. The reason for this discrepancy is likely due to the use of 1986 survival rates rather than 1971. Life expectancy woud have been lower in 1971 and therefore more deaths would have been anticipated. Therefore, using 1986 survival rates would underestimate the number of deaths within the projection.

Natural Increase

With births being overestimated and deaths being underestimated, it is no surprise that natural increase is well above that reported by Statistics Canada. Over the entire 25 year forecast period, natural increase was overestimated by approximately 130,000 individuals or about 5,200 annualized. This large overestimation can be attributed to two identifiable reasons, already mentioned. First, the fertility rate dropped substantially over the forecast

Figure 4.5



period, and was not captured by the model, which led to a projection of births well above the actual level. Second, deaths were underestimated for previously stated reasons. There is a third possible reason for the overestimation of natural increase and that is migration.

Migration

The net migration record as supplied by Statistics Canada was used in the model to largely eliminate this usually estimated or forecasted variable. Theoretically, this "true" record of migration should not be a factor in the projection, as it corresponds to the actual history of migration over the forecast period. In reality, we must consider the possibility that the record is not entirely accurate, and that net migration values may have been different than what Statistics Canada reported. This is a factor that cannot be known for certain, but must be considered. For instance, if out-migration was higher at the beginning of the forecast period than reported, those individuals that are actually gone will be considered to have births, which will subsequently inflate the level of population. Put another way, net migration affects the population level directly, so that errors have the capacity to skew the projected values substantially by the end of the forecast period. In thecase of the present projection, the assumption would be that net migration values were understated, or that more people left Saskatchewan than the record indicated, which would have inflated population values. However, this is speculative since the birth and death rates themselves caused an inflationary population forecast that may account entirely for the overestimation of population. More projections would have to be run to

Table 4.3

Births, Deaths & Natural Increase
PHD Projection vs Statistics Canada

Year	Births PHD	Births Stats Can	Difference	Deaths PHD	Deaths Stats Can	Difference	Natural Increase PHD	Natural Increase Stats Can	Difference
1972	16333	15456	877	5972	7563	-1591	10361	7893	2468
1973	16348	15280	1068	6033	7591	-1558	10315	7689	2626
1974	16601	14680	1921	6112	7806	-1694	10489	6874	3615
1975	17281	15217	2064	6200	7681	-1481	11081	7536	3545
1976	18390	15809	2581	6321	7765	-1444	12069	8044	4025
1977	19365	16328	3037	6432	7830	-1398	12933	8498	4435
1978	20121	16463	3658	6530	7657	-1127	13591	8806	4785
1979	20729	16813	3916	6623	7318	-695	14106	9495	4611
1980	21351	16906	4445	6709	7642	-933	14642	9264	5378
1981	21869	17201	4668	6800	7514	-714	15069	9687	5382
1982	22419	17359	5060	6889	7822	-933	15530	9537	5993
1983	22943	17856	5087	6988	7969	-981	15955	9887	6068
1984	23394	17912	5482	7085	7675	-590	16309	10237	6072
1985	23709	18137	5572	7186	7872	-686	16523	10265	6258
1986	23687	17916	5771	7275	8128	-853	16412	9788	6624
1987	23494	17461	6033	7356	7862	-506	16138	9599	6539
1988	23103	16604	6499	7432	8079	-647	15671	8525	7146
1989	22363	16772	5591	7504	7875	-371	14859	8897	5962
1990	21523	16499	5024	7577	8059	-482	13946	8440	5506
1991	20765	15655	5110	7648	7921	-273	13117	7734	5383
1992	20298	15177	5121	7726	8061	-335	12572	7116	5456
1993	19961	14631	5330	7813	8013	-200	12148	6618	5530
1994	19729	14068	5661	7914	8273	-359	11815	5795	6020
1995	19570	14013	5557	8021	8244	-223	11549	5769	5780
1996	19552	13765	5787	8111	8550	-439	11441	5215	6226
Grand Total	514898	403978	110920	176257	196770	-20513	338641	207208	131433

Source: CMHC & Statistics Canada

answer the question of net migration accuracy and the answer would likely be less than certain. For the purposes of the present study, net migration values from Statistics Canada are assumed to be accurate and to have no subsequent influence over projected population levels.

II Household Projection Model

The household projection model is composed of two essential and one optional demographic characteristics.

1) Projected Population: this is the population structure in a given jurisdiction by one year cohorts, that was input from the population model.

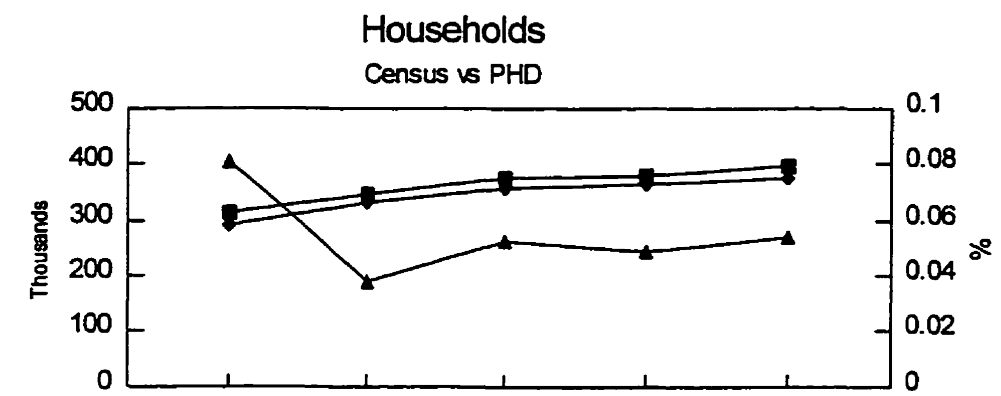
2) Headship Rates: represents the probability that a member of a given age group will head (maintain) a household of a given type (family or non-family). The headship rate is calculated as the ratio of household heads in an age group to the population of that age group. (Saskatchewan 1971 Headship Rate - Statistics Canada)

3) Family Proportions (optional): describes the proportion of family types - couples without children, couples with children, lone parent households and multiple family households. (Saskatchewan 1971 Family Proportions - Statistics Canada)

Household Projection Method

Essentially, family and non-family households are projected by multiplying projected age-group populations by projected age-specific family and non-family headship rates.

Figure 4.6



	1976	1981	1986	1991	1996
PHD	314738	345217	377099	380800	395911
Census	291153	332712	358268	363149	375740
Difference	8.1%	3.8%	5.3%	4.9%	5.4%

Source: PHD Model & Statistics Canada (Cat #95-365)

Household Results

Projected households generated by the PHD model were compared to the census record. The household demand model overestimated the absolute number of households as compared to the census record (see Figure 4.6). This is expected given the overestimated population projection used as input to generate the household projection. *However, the PHD model did not overestimate the overall level of households less accurately, as the forecast horizon extended farther out, as it did in the population model.*

Household Growth

While the absolute number of households gives us an indication of the model's performance, the level of household growth as compared to the Census record is the factor of real interest since the primary use of the model is to obtain a projection of how many new homes will be required to satisfy demographically-driven demand.

The accuracy of the PHD model must be weighed against the census rather than the housing starts record, as this is a comparison of household growth only. The housing starts record is a combination of household growth and the addition of stock to replace the deteriorated and/or converted residential dwellings within a given period, minus a normal (1%) level of vacant units. Therefore, housing starts are an indirect comparison

Figure 4.7

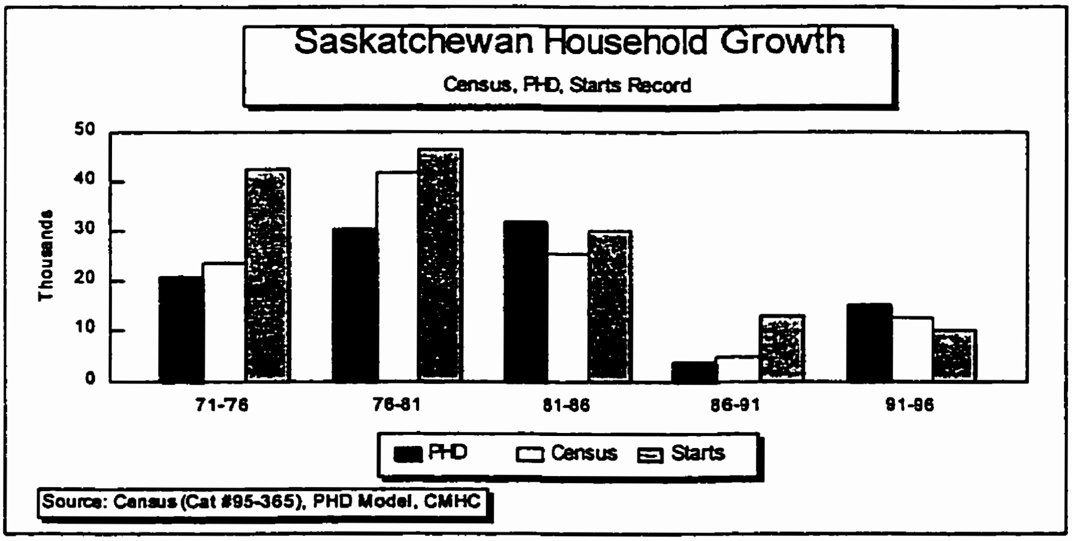
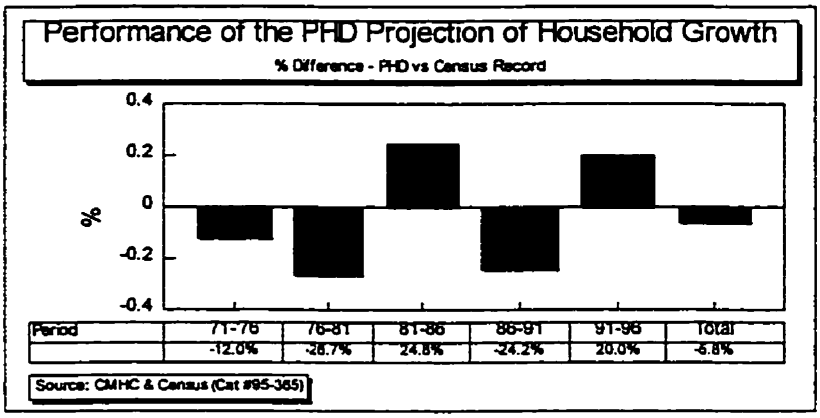


Table 4.4 - A Comparison of Household Growth

Household Growth				**% Net Difference in Household Growth**		
	PHD Model	**Census Record**	**Starts Record**	**PHD to Census**	**PHD to Starts Record**	**Census to Starts Record**
'71-'76	20,755	23,588	42,563	-12.0%	-51.2%	-44.6%
'76-'81	30,479	41,559	46,316	-26.7%	-34.2%	-10.3%
'81-'86	31,882	25,556	30,177	24.8%	5.6%	-15.3%
'86-'91	3,701	4,881	13,072	-24.2%	-71.7%	-62.7%
'91-'96	15,111	12,591	9,987	20.0%	51.3%	26.1%
Total	**101,928**	**108,175**	**142,115**	**-5.8%**	**-28.3%**	**-23.9%**
Source: Compiled by Author						

requiring further calculation and estimation. Housing starts have been included here to shed light on the historical relationship between housing starts and household growth in Saskatchewan within the last 25 years. The relationship between housing starts and household growth is a topic unto itself, and beyond the scope of this study. Figure 4.7 illustrates household growth for the PHD model, the Census record and the housing starts record for Saskatchewan from 1971 to 1996. Table 4.4 gives the raw numbers and the percentage net difference between these sets of data. The first thing to note is that the PHD projected household growth and that recorded by the Census is similar. The total growth over the 25 year period (Table 4.4) is 101,928 in the case of the model, and 108,175 in the case of the Census. Overall, growth was underestimated by 5.8 per cent by the PHD model in comparison to the Census record. Both sets of data underestimated the number of housing starts for the 25 year period recorded by CMHC - by 28.3 per cent in the case the PHD model and by 23.9 per cent in the case of Census.

Figure 4.8



The PHD model was closest in its prediction of household growth in the '71 to '76 period. Its worst period of prediction was after '76 to '81. The model either over- or under-estimated growth by about a quarter of its true value as recorded by the Census within a five year period. Over the 25 year period, the performance seems reasonable, but it masks wide swings in its five-year predictive performance. The PHD model actually predicted a more accurate value for household growth for the entire 25 year period than it did for any 5 year census period.

III Dwelling Choice Propensity

Dwelling choice propensity refers to splitting projected households into owner and renter groups by applying projected ownership propensities to household projections. The model also distributes projected household tenure groups among four dwelling types: single detached homes, apartments, other multiples and moveable dwellings. The calculation applies projected dwelling choice propensities to projected household tenure groups.

To evaluate how the PHD model performed, the record of occupied private dwellings by structural type and tenure was obtained for the period of construction from 1971 to 1990. The data from 1991 onwards was not yet available at the time of this study.

Table 4.5 - Dwelling Choice Propensity

Saskatchewan	1971-1990 Record	%	PHD model	%
Total Dwellings	162570		85510	
Owned	108715	66.9%	58455	68.4%
Rented	49420	30.4%	27046	31.6%
Band Housing	4445	2.7%		
Single-detached	109620		62028	
Owned	96120	87.7%	53755	86.7%
Rented	9160	8.4%	8273	13.3%
Band Housing	4345	4.0%		
Apartment	7550		14126	
Owned	630	8.3%	1170	8.3%
Rented	6915	91.6%	12956	91.7%
Band Housing	0	0.0%		
Movable Dwelling	7820		2400	
Owned	6945	88.8%	2100	87.5%
Rented	855	10.9%	300	12.5%
Band Housing	30	0.4%		
Other dwellings	37580		6956	
Owned	5005	13.3%	1430	20.6%
Rented	32485	86.4%	5526	79.4%
Band Housing	85	0.2%		

Source: Statistics Canada (Cat #93-314) - Occupied Private Dwellings, 1991 - 20% Sample Data

The data from Statistics Canada must be interpreted in light of the fact that homes constructed within this period also replaced deteriorated or converted housing stock, and not simply housing stock based on housing demand deriving from household growth. However, one can assume that replaced stock still should have been subject to the same dwelling choice propensity as new stock. In any case, the data obtained remain the only method of evaluating tenure propensities by dwelling type identified by this researcher.

The PHD model performed remarkably well when forecasting dwelling choice propensity. When considering total dwellings by tenure, the PHD model projected 68.4 per cent level of ownership, with the balance being rented. The record obtained from Statistics Canada reported a 66.9 per cent level of ownership and 30.4 per cent level of rented accommodation with the balance being in band housing. This amounted to a discrepency of 1.5 percentage points for ownership and 1.2 percentage points in the case of rental.

The one exception was the instance of "other dwellings" where the model overestimated the percentage of owned dwellings and underestimated the amount of rented dwellings by about seven per cent. In the case of apartment type, the model predicted the dwelling choice propensity one hundred per cent correctly.

The high rate of forecast success for dwellings choice propensity is largely due to the fact that dwelling choice propensity is one the more stable aspects of housing stock characteristics (generally a third of the market will be rented tenure while the remaining two-third will be ownership). This is probably especially true over the longer term. The nineteen-year period considered in this study support that assumption.

Chapter Six

Conclusions & Summary of Findings

Projections and forecasts play an essential role in everyday planning practice. Planners are counted upon to analyze and to predict future trends. There have been a host of differing methods developed over the years to address the need for predictions in city planning. Some methods are more technically sophisticated than others and are thought to generate more accurate forecasts due to a more theoretically comprehensive approach. Studies evaluating the performance of forecast do not support that hypothesis. Rather, their performance was found to be dependent on length of forecast horizon and the validity of the core assumptions inherent in the model itself.

The performance of Canada Mortgage and Housing's Potential Demand Model was largely consistent with the findings of past studies evaluating forecast performance by such authors as Andrew Isserman, Norbert Oppenheim and Willian Ascher. As described in chapter two, the essence of the cohort-component model is applying the correct rates to the number of people in each cohort. This type of projection makes clear what is being assumed. However, the model has no inherent theories about the determination of those rates. Once again, these rates, which are the essence of what the model will ultimately predict, must be decided upon by the analyst. In a model like the

PHD, there are many rates to consider and it is not straightforward or easy to decide upon the future value of those rates, even by the most seasoned and experienced analyst.

This study concerned itself with an evaluation of one baseline projection rather than an evaluation of many projections and forecasts as was the case in past research. The rationale of evaluating one projection in detail rests in the fact that users will inevitably generate this mechanical projection, even if it is only as a first approach. Considering that the use of projections is widespread (see page 24), the performance of a baseline projection becomes critical. However, few studies have been conducted in this regard.

The appraisal of CMHC's PHD model was consistent with past evaluative efforts and centered on two key aspects: forecast accuracy and theoretical coherence. Accuracy and those theoretical assumptions that detract from or enhance accuracy are emphasized by past research literature. The criterion of accuracy is strongly defended from the policy making perspective. Projections and forecasts are generated as useful tools to glimpse the future. Therefore, the credibility of these tools are crucial to substantiate improved decision-making capability. No forecast could be considered worthwhile, if it was not perceived as credible and thus persuasive. This study serves as a initial glimpse into an important question for city planners. Namely, to what degree can mechanical projections be relied upon in planning future communities? What follows is a summary of the findings which represent a step in answering this important question for city planners.

Summary of Findings

The case study analysis of a simulated historical projection of CMHC's Potential Housing Demand Model (1971-1996) for the province of Saskatchewan revealed the following:

1. The population of Saskatchewan was overestimated for the projection period. This population overestimation grew larger as the time horizon grew more distant. Therefore, this substantiated the following past research finding: *a forecast time horizon is the strongest and most consistent correlate of its accuracy.*

2. The overestimation of population was largely attributable to the fertility rate assumption. The 1971 fertility rate was projected throughout the forecast period. This rate fell considerably within this period, leading to an inevitable overestimation of births and population growth. Consistent with past research this demonstrated: *the essential importance of the validity of core assumptions.*

3. The household demand model overestimated the absolute amount of dwellings as compared to the census record. This was expected, given the overestimation of population growth. *However, the PHD model did not overestimate the overall level of households less accurately as the forecast horizon extended farther out.*

4. Over the entire 25 year projection period, household growth was underestimated by 5.8 per cent by the PHD model in comparison to the Census record. The five-year predictive performance of household growth demonstrated moderate over- or under-estimations. In contrast to past research: *the PHD model actually predicted a more accurate value for household growth for the entire 2 year period than it did for any year census period.*

5. The PHD model performed remarkably well when forecasting dwelling choice propensity. When considering total dwellings by tenure, the PHD model projected 68.4 per cent level of ownership, with the balance being rented. The record obtained from Statistics Canada reported a 66.9 per cent level of ownership and 30.4 per cent level of rented accommodation with the balance being in band housing. This amounted to a discrepancy of 1.5 percentage points for ownership and 1.2 percentage points in the case of rental.

Some Reflections on the Study

As previously stated, the case study was largely consistent with past research evaluating forecast performance. The most prominent finding in this case study analysis of the PHD model was the inability to project a fertility rate trend over the forecast period. The validity of this assumption becomes apparent to forecast accuracy over longer time horizons. The inability to account for a changing fertility rate detracts from the theoretical coherence of the model, since fertility rates have shown marked change between census periods. Therefore, assuming the rate will not change over the forecast period of twenty-five years is clearly unwarranted, and should have been addressed in model development. However, it remains that for a city planner interested in using the PHD model, the output of the model must be interpreted in light of this reality. If the fertility rate is expected to drop during the forecast period, then an overestimation of population will occur, ultimately affecting final household demand. Likewise, an under-estimation would occur if the fertility rate was expected to increase over the projection period. Further study of the model might address the sensitivity of output in relation to fertility rate assumptions, that is, how much change in fertility rate affects overall population levels. This would shed light on the adoption of specific rates when departing from a baseline projection, and how it would ultimately impact the population levels and household growth. However, it remains that when a planner or analyst uses the model, even if only for a baseline projection, the fertility rate assumption must remain the same over the projection period. This will always be problematic when using the model since in reality the fertility rate will almost certainly change.

This case study illustrated one of the most common aspects of, and ultimately the problems with projections and forecasts. No matter how the model quantifies and conceptualizes the world, the assumptions inherent in its workings are key; they are the cornerstones on which the model is built and from which it derives its ability to project/forecast. Therefore, the level and trend of those rates must be decided upon to arrive at a future picture of the variable of interest. This is always open to varied interpretation and ultimately, user judgement will be the driving force. At the forefront, it must be kept in mind that these models are really only a tool allowing planners to formalize and extend their judgement; they cannot be perceived as providing a concrete recipe for glimpsing likely future scenarios.

The distinction between projections and forecasts discussed in this praticum have implications for professional planners. Planners are expected to provide professional judgments on often difficult questions or issues. This study highlighted that the use of technical projections, which can be done solely by a technician, may fall short when estimating future values. As professionals, planners must consider contextual factors in addition to solely technical ones and move towards generating a forecast, rather then simply relying on projections whose assumptions remain hidden and unscrutinized.

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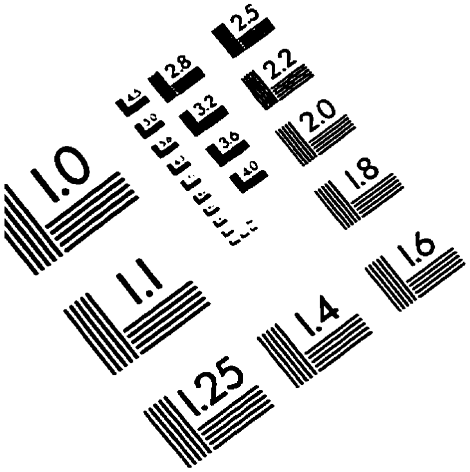
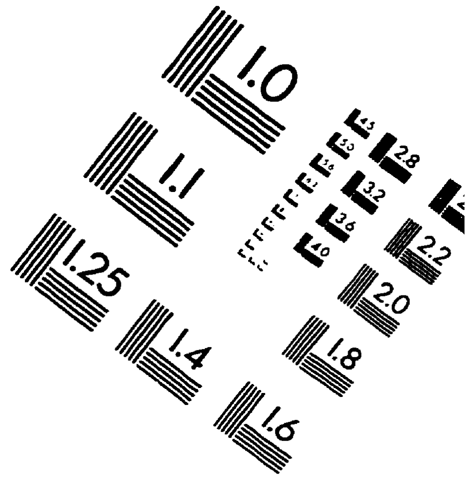
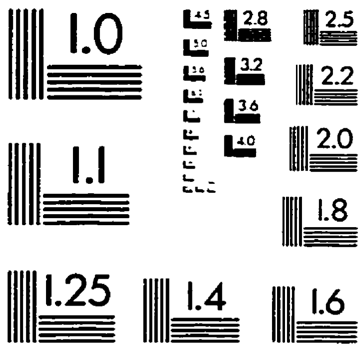
IMAGE EVALUATION TEST TARGET (QA-3)







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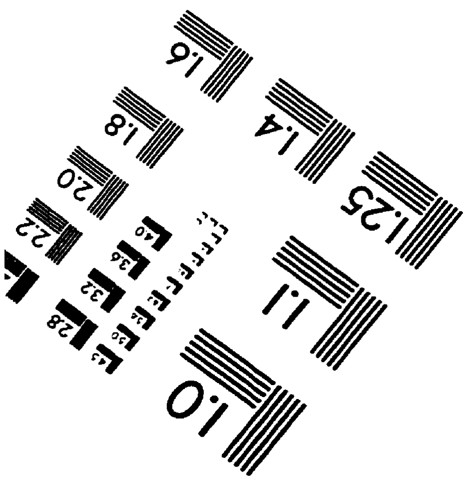

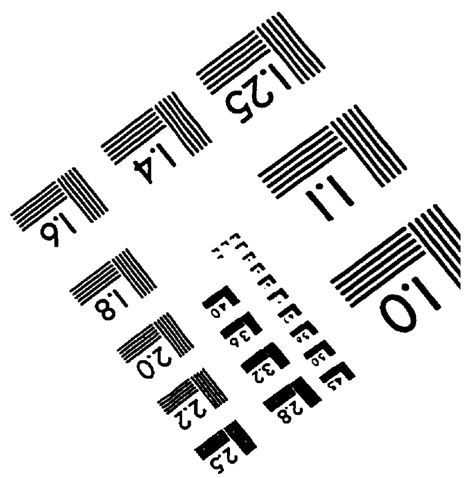

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