MULTIREGIONAL POPULATION ANALYSIS FOR URBAN AND REGIONAL PLANNING

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INTRODUCTION

During the past few years, we have witnessed the appearance of a new generation of models for urban and regional analysis and planning. Following the systems idea that everything depends on everything, analytically-oriented demographers, economists and planners have expressed a growing dissatisfaction with "one-at-a-time" regional models. As an alternative, a multiregional approach has been advocated, in which regions are represented as components of a larger, interconnected system. This new model structure is proposed as an improved tool for the assessment of spatially differentiated impacts of national and/or regional policies. Multiregional models not only recognize the relationships that exist between regions, and are able to trace both the direct and the indirect interaction effects, but they also yield consistent regional and national statistical measures. The consistency of results with national totals has always been a difficult issue in regional modelling; it was never adequately resolved until a model structure was developed in which all regions of a nation were considered simultaneously.

In trying to construct multiregional model structures, economists and demographers went through conceptually similar designs, which may be classified into four groups: (i) the top-down approach, (ii) the bottom-up approach, (iii) the hybrid approach, and (iv) the multiregional approach. The approaches are reviewed in the first section of this paper. Many of the models actually used for regional forecasting and policy analysis are still of types (i) to (iii). However, as scientists simplify the mathematics of multiregional models, gather experience in using them, facilitate the application by providing packages of computer programmes, and, last

but not least, develop accurate estimation techniques to fulfil data requirements, the multiregional perspective is within reach of more agencies, and it is being adopted rapidly.

The selection of a particular model-type for regional forecasting and analysis is frequently the outcome of an evaluation process in which a more or less standard set of questions is asked. The second part of this paper reviews some of the important questions and attempts to provide an answer. The questions relate to model characteristics (degree of complexity to adequately represent reality, suitability of the model for impact assessment, consistency and reliability of the numerical results), and to the feasibility and even desirability of its application in view of the limited availability of statistical data and the lack of manpower. These are two of the major factors that Pack (this volume) puts forward as affecting the actual use and institutionalization of models in regional planning agencies.

APPROACHES TO MODELLING A SYSTEM OF REGIONS

The rationale for modelling a system of regions instead of a set of independent regions is threefold. First, the awareness of the regional identity: regions behave differently and models should be able to fully represent these differences. Second, interregional dependence: regions do not exist in a vacuum; they are interconnected with other regions, which they influence and by which they are influenced. Third, the need for consistency in regional projections and impact assessments: for each variable, the value for the nation must equal the sum of regional values (stock variables), or must be a weighted average (rate variables). Several ad hoc procedures, that exist to impose consistency, are no longer acceptable on scientific grounds. The approaches to modelling systems of regions reflect the response to these three requirements.

The Top-down Approach

The top-down approach is a common way to project regional economic and demographic variables. It is attractive because it ensures consistency. The procedure is simple: national variables are estimated first and then distributed among regions on the basis of a predefined allocation procedure. The allocation procedure may be extremely simple, such as the fixed-ratio technique, in which the regional variable is a fixed share of the national total. Some procedures, particularly in economic models, are quite complex and apply mathematical programming to determine the regional distribution that optimizes a welfare, cost or information gain index, and at the same time satisfy the national control totals. Regional growth models, if used at all, are satellites of the national model.

Most demographic models are of the top-down type. Ter Heide (1976) and Pittenger (1976) provide an extensive discussion of distribution functions. National totals are generally taken from projections of a country's population, that are prepared by statistical offices. The official or semi-official nature of national statistical offices and of the numbers they produce explains the reluctance of analysts to produce deviating projections, and hence the popularity of the top-down approach. As in many other countries, this approach is being followed in the Netherlands to produce regional population forecasts. The Dutch model has, however, several features that show the form of a hybrid model. By intensive use of standardization techniques, the model can account for autonomous changes in regional population compositions (Eichperger, Hamel and Nieuwenhuis, 1979).

In a review of so-called multiregional economic models, Bolton (1980) classified most of them as top-down models. An illustration is MULTIREGION, developed by Olson and associates (1978) at Oak Ridge National Laboratories; it is an input-output model, driven by Almon's INFORUM model of the national economy. MULTIREGION predicts the region's share of national employment in each industry on the basis of changes in key economic indicators, of which the most important is the region's accessibility to the national market.

The top-down approach is convenient from a practical point of view since the consistency problem does not exist. It may also be defended on a theoretical basis. What happens in a region is very much determined by what happens in the nation. This statement underlies, for instance, the economic base theory which claims that regional growth is driven by a "basic" sector producing for the national, or even, international market. The economic base multiplier denotes the impact on total regional employment of changes in basic sectors. The employment describes, therefore, the effects on the region of changes originating at the national level. The validity of the economic base theory has been questioned recently, mainly because of its pure demand orientation and ignorance of the supply constraints of production factors. A focus on supply conditions would logically call for a more region-oriented perspective, and hence, for a different modelling approach.

The selection of a top-down model of regional change implies the adoption of a particular theoretical perspective which may be questioned. The main drawback of the approach is, however, that at the outset regional differences are disregarded. National projections or indicators are produced by assuming "average" values of model parameter and initial conditions. Regional differences are only introduced at a secondary stage, in which national projections are distributed.

The Bottom-up Approach

The second approach is to analyze or project regional variables completely independent of national control totals. Each region is treated as a separate sub-system without any explicit links with any other region. This "uniregional" perspective gives maximum weight to regional characteristics and is therefore attractive when the emphasis is on regional differences rather than on consistency or interdependence. This is the case, for instance, when attention is limited to a single region, or when supply conditions largely determine regional change.

The bottom-up approach leads to inconsistent results. The value of a national variable is the sum of regional variables, and nothing assures that this sum equals the national control total. Although the uniregional perspective implies that each region is independent from the others, it does not require the regions to be closed. Interactions with other regions of the same system may be accounted for through variables representing net exchange. A typical illustration is the net migration variable. Usually the regional population is projected by a cohort-survival model, a technique originally developed for projecting national populations. The assumption of closedness may be realistic at the national level, but it does not hold for sub-national units. The cohort-survival model is therefore adapted to the new situation by adding a net migration variable. The use of net migration, and of net exchange in general, is a simple procedure, but has a number of important theoretical and methodological shortcomings, as will be shown in the second part of this paper.

The Hybrid Approach

The hybrid approach is a first attempt to combine the advantages of the top-down approach (consistency) and the bottom-up approach (explicit consideration of regional differentials). In it, some regional variables are sum-constrained, ie. constrained by values determined by a national model. The predetermined national totals are regionally-independent, while the other totals, which are obtained by simply summing the regional variables, are regionally-dependent. The movement away from the pure top-down approach is a response to the need for more realism in models of systems of regions. Regions do not always follow national developments: they have their own internal dynamics, and may also generate national change. There is, therefore, a need for a double linkage: national-regional (top-down) and regional-national (bottom-up).

The hybrid approach is used in several "multiregional" economic models developed in Europe. The REGINA model for France, developed by Courbis (1975), is the best illustration. Courbis's ideas have recently been adopted by Ballard and Associates (1980a, 1980b) of the US Bureau for Economic Analysis in NRIES.

The hybrid approach combines a national model and several regional models. Employment and labour supply are the most important variables generated by the regional models, reflecting the fact that labour markets are regionally bound. Population level, interest rates, exports and imports are among the variables determined by the national model, and are subsequently used as control totals for the regional models.

For population projection, a hybrid model is being used in the US, Canada and Sweden, and the hybrid nature relates to the way migration is treated. Migration has always caused major problems for sub-national population projections. Application of a net migration variable violates an important consistency requirement: without international migration, the net migration rate for the nation should be zero. To ensure consistency, the concept of "migrant pool" was introduced. For each region, the number of outmigrants is calculated independently by applying fixed region-specific outmigration rates. The national total of outmigrants is obtained by simple summation. To get the number of immigrants in each region, the migrants in the "pool" are allocated to the regions by using a distribution function. The choice of this procedure rests on theoretical and empirical bases. Theoretically, immigration rates should not be calculated since the base population is not the population at risk of migrating. A "propensity to immigrate" has no theoretical meaning. In addition, there is the empirical observation that the outmigration rate of a region is much less volatile than its immigration rate, and hence, easier to predict.

In some instances, it may be acceptable to calculate the immigrants first, to generate an "immigrant pool" and to obtain outmigrants by a distribution function. For instance, Gordijn and Heida (1979) use an "immigrant pool" since in the Netherlands migration is very much determined by housing opportunities. Because of the relation between housing construction and immigration, immigration is easier to predict.

The Multiregional Approach

In the first three approaches to modelling systems of regions, the emphasis was on consistency with national totals, and on regional differences. In the multiregional approach, the concern for consistency and regional differences is augmented by a concern for correctly representing and projecting interregional dependencies. Regions interact with one another by exchanging people, goods and services. Modelling migration, commuter and trade flows by region of origin and of destination has generated substantial research in geography and regional science, which is currently referred to as spatial interaction analysis, and which is a growing sub-field in both disciplines. Spatial interaction analysis may formally be defined as the study of observed interregional (origin-destination) flows, and the estimation of flows from incomplete data. A critical

ingredient of multiregional models is a spatial interaction model. The development of the spatial interaction analysis is appropriate, particularly if not all the required statistical data are available. The next section of the paper looks at data availability as a limiting factor in multiregional analysis, and at estimation procedures to alleviate the data problem.

The dominant feature of multiregional models is that they study and project all regions of a multiregional system simultaneously. In the previous approaches, the regional variables and/or national variables are solved sequentially. Consistency is assured by a negative feedback mechanism. The simultaneous solution of all regional variables not only assures internal consistency, but, at the same time, enables the introduction of regional differences and the representation and projection of linkages that exist among regions. It is an appropriate approach to study the indirect, as well as the direct, effects on the system of changes in a particular region. The multiregional perspective is therefore advocated for regional and urban impact assessment of policies at national and sub-national levels (Glickman, 1980). As Glickman indicates, an essential aspect of sound impact studies is that the impact of policy is analyzed in terms of both indirect and direct effect. In addition to the scientific and policy relevances of the multiregional approach, there is a practical reason for adopting this approach. The level of detail of multiregional models forces the analyst or user to devote more attention to the input, and to spell out the assumptions with greater care than is needed in other types of models of multiregional systems. This demand for increased attention to assumption specification may prove to be a very useful fringe benefit of multiregional models.

This approach to modelling systems of regions is not widely applied yet. A prototype of a multiregional model of the economic system is Polenske's (1975) input-output model. Regional tables are linked by industry-specific interregional trade coefficients. Although in the original version of the model the trade pattern is assumed to remain constant, there is no technical barrier to introducing changes. More important is the economic theory imbedded in the models, which is Keynesian. Input-output models are demand-oriented and assume a perfectly elastic supply. This paradigm of the economy is transposed to interregional trade. Trade flows are completely determined by input requirements, and are independent of production constraints. The trade coefficients are admission rates.

In demographic analysis, the multiregional approach was introduced by Rogers (1975), who generalized conventional demographic concepts and models to multiregional systems. The multiregional perspective is also adopted by Rees in his work on demographic accounting (see, for instance, Rees and Wilson, 1977). Regions are linked through age-specific directional migration flows. The migration coefficients are derived from base-year data. They are transition rates, ie. outmigration rates, and applied to the population in

the region of origin. If flow data are not available, they may be estimated from whatever relevant information exists (Willekens, Por and Raquillet, 1979). Regional differences are easily accounted for: the fertility and mortality parameters are region-specific. This leads to the question of consistency: are the aggregates of multiregional population analysis and projections consistent with national characteristics and projections? The consistency issue is investigated in the next part. Whether consistency is achieved depends primarily on the relative differences in regional fertility and mortality levels, and not on the migration pattern. The consistency condition is satisfied if, and only if, the multiregional model imbeds the same set of assumptions as the national model. This sounds promising, but it is not. One could defend the thesis that the aggregates of multiregional analysis should deviate from the totals obtained by a national model, and that the national totals obtained by a multiregional model are closer to reality.

ISSUES IN MODELLING A SYSTEM OF REGIONS

In order to be a useful tool for forecasting and policy analysis, a model should satisfy a few conditions. It should be theoretically sound, represent reality, have a high internal validity (internally consistent), yield reliable and accurate results of an acceptable level of geographical detail, and it should be simple, transparent, easy to implement and should respond to "what if" questions. Some of these requirements are associated with some fundamental modelling issues. I would like to focus on four issues: (i) consistency, (ii) level of disaggregation, (iii) ability to simulate, i.e. to answer "what if" questions, and (iv) implementation (application).

Consistency

The rationale of the top-down approach is that the sum of regional projections should be equal to national control totals. Although, from a practical point of view, this consistency requirement may be necessary, it is theoretically unacceptable. Control totals are obtained by applying nationally average rates of growth. Control totals may therefore be thought of as the sum of regional projections with identical growth rates. In other words, in adopting control totals, one assumes the system to be homogeneous, and to completely ignore regional differences. The introduction of heterogeneity in the system by allowing regional growth rates to differ would generally lead to other totals. This can easily be demonstrated. Assume a system consisting of two regions. The first region has 2000 people, and the second, 8000. The regional growth rates are -0.01 and 0.015 respectively. The average growth rate is 0.01. Applying the average growth rate to the population of 10,000 yields a population of 10,510 after five periods. Applying the regional growth rates to the regions separately would give a popula-

tion of 10,520. That the sum of separate projections is larger than the projection of the combined population was already shown by Keyfitz (1972). Now assume that people can migrate between the regions. If both regions grow at the same rate, then migration does not affect the total population, but only its distribution over space. If the regional rates of natural growth differ, then migration neutralizes some of the effects of these differences: the total population is closer to the population figure obtained by applying the national rate. The effect of migration is, therefore, to level off the impact of regional differences. This phenomenon has been denoted as the regression-towards-the-mean effect of migration in multiregional analysis.

In demographic and economic analysis, the consistency issue has been dealt with extensively; for a recent review of the state of discussion, see Gibberd (1980). Gibberd, building on Rogers (1976) shows that the necessary and sufficient conditions for perfect aggregation in multiregional models is that the Markov property holds for both the aggregated and the disaggregated process; in other words, that the Markov property is not destroyed by the aggregation. The reader is referred to the literature for a detailed discussion.

How Disaggregated Should a Model Be?

Do we need a highly disaggregated and complex model if the only interest is on some aggregate indicators, such as the total population? Isn't a simple exponential growth model sufficient? The optimal level and type of disaggregation of a population system for projection and analysis purposes depends on three considerations: use of projection or analysis, demographic theory and statistical theory (Willekens, 1979).

Use of Projection: The elements of the population structure may be selected because predictions of sub-categories are of value in their own right. If age-specific population data are required, an age-specific model should be used. An alternative, which is still used in some instances, is to project the total population and to apply a distribution function to decompose the population into age groups. A problem is that the "user" of projections is generally not known or is highly diverse, in particular, if projections are made by statistical offices. It shows a lack of realism if one wants to please all potential users by a single projection output. Flexibility in output format is, instead, a more realistic strategy.

The interest in a projection model may not be limited to its output. In "what if" analysis, the input is as important as the output. A highly disaggregated regional model with a detailed input structure offers more entry points for simulation use. This increased ability to simulate may justify the additional effort of disaggregation.

Demographic Theory: How large should a demographic projection model be? In other words, how complex should the projection system be? This issue is often the subject of debate between model developers and users. Complexity and forecasting accuracy are not proportional. A simple projection model, such as the scalar exponential growth model in which the projection system consists of a single element, may yield highly accurate results, in particular, in the short run. Whether this could be a result of simple dynamics, or of a complex interaction of neutralizing forces is always uncertain. To eliminate this type of uncertainty, the choice of the appropriate projection system and its constituent elements must also be determined by demographic insight. An aim of demography as a science is the identification and explanation of regularities in demographic processes. A review of the demographer's search for regularity and for the fundamental components of demographic change is presented by Brass (1974). This knowledge provides a theoretical basis for the design of the projection system. "Demographic forecasting is seen as the search for functions of population that are constant through time, or about which fluctuations are random and small." (Keyfitz, 1972:347). A first step to this ideal situation is the detection of homogeneous sub-groups of the population. This statement has an important implication for the definition of the spatial system: the spatial units of analysis, selected for projection purposes, should be as homogeneous as possible with regard to the demographic characteristics (Ter Heide, 1973:460). This is contrary to the geographer's search for natural spatial units (settlement clusters) which are both territorial and functional (see, for instance, Dziewonski, 1978:40). The search for homogeneous categories at the outset of the projection exercise, facilitates the scenario-analysis at a later stage, and the interpretation of the results.

Statistical Theory: The demand for disaggregation to achieve greater homogeneity within categories is constrained by the need for statistical data. Disaggregation becomes excessive if the number of observations (sample size) in a certain category is too small to allow a calculation of representative indicators, eg. transition probabilities. Although this requirement seems trivial, it is often not met, particularly in large simulation models in which size and empirics prevail over quality and substance.

The optimal internal structure of the projection system is a compromise. Demographic detail and statistical significance are conflicting objectives. The statistical requirement of adequate sample size in each category can be dealt with by using auxiliary models to generate the values of the demographic model parameters (Willekens, 1980a). In highly disaggregate systems, the observations in each category (cell frequencies or probabilities) may not be independent. The pattern of association may therefore be described by relatively simple models. These models are intermediate between the data and the parameters of the demographic models, and are tools for information reduction. The demographic parameters are not directly calculated from the observed data, but are derived from

models fitted to the observed data. Examples of auxiliary models that may be used when the observations are too small in number, or even missing completely, are the so-called model schedules. The observed age-specificity of fertility, mortality and migration has induced demographers to describe the curves of age-specific rates by simple models (Coale and Demeny, 1966; Coale and Trussel, 1974; Rogers and Castro, 1979). The results of this research may fruitfully be applied in simulations of highly disaggregated population systems.

"What if" Analysis

To be useful for planning and policy-making, models should assist in answering relevant questions. They can do so if they incorporate an "ability to simulate". Forecasting, policy impact assessments and sensitivity analysis are particular illustrations of "what if" analysis or simulation. In forecasting, the interest is on the evolution of the system if the external conditions (environment) and the model parameters take on their most likely values. In policy analysis, the interest is in knowing how the system responds to anticipated changes in policy variables. To perform "what if" analysis, the mathematical model must be linked to a procedure to translate general judgments about prospective changes into specific assumption statements directly related to model variables and parameters. Such a procedure is scenario-writing. The scenario-writing process consists of two steps: identification of scenario-variables and assignment of specific values to these variables.

Identification of scenario-variables: scenario-variables are a subset of the variables and parameters of the mathematical model. Parameters or variables not in the model can, therefore, not be part of the scenario. As already mentioned above, the model structure should reflect the desired scenario analysis. A demographic model, for instance, is unable to trace the impact of the energy crisis on population growth and distribution, since it does not contain energy variables. The choice of the appropriate scenario-variables has generated already considerable discussion. A remark, made frequently with regard to purely demographic models of regional population growth, is that migration levels and directions are closely tied to variations in socio-economic conditions, and that, therefore, migration should be endogenized by linking the demographic model to one or a series of models of socio-economic change. Scenario-variables should not directly relate to migration levels and directions, but to the factors explaining migration. Although very realistic at first glance, this claim is only justified if three conditions are met (Brass, 1974:565): (i) the relation between migration and the explanatory (socio-economic) variables must be a close one, (ii) the relation must persist over time, and (iii) the explanatory variables must be predictable, with a greater accuracy than the demographic measures.

If one of these conditions is not met, then the endogenization of the migration variable cannot improve the reliability of the results. In an era of economic uncertainty, the potential of demographic-economic models for improving population forecasts may be limited. Instead, an intermediate approach may be fruitful. It consists of two steps. First, migration rates by migrant categories are treated as scenario-variables. It presents the impact on population distribution of changes in migration pattern. The impact can completely be attributed to the features of the demographic system. Second, an explanatory model of migration is added, and the impact on migration of changes in some of these explanatory variables is studied. Assuming independence of effects, the total impact of changes in socio-economic conditions on population distribution is the product of the two impact measures.

Assignment of values to scenario-variables: Unlike in policy impact assessment, the most difficult part in forecasting is the assignment of values to scenario-variables. The selection of values, the scenario-variables are most likely to take on in the future, requires courage, demographic insight, some vision and a good deal of luck. Most forecasters solve this problem by providing the user with a set of alternatives. In many instances, this strategy creates more problems than it solves. Since forecasts frequently have their own independent lives, it becomes very difficult, if not impossible, to select between them without reference to the details of their preparation. The proper debate on the population forecasting issue should centre on the process of assigning values to scenario-variables, since it is in this process that judgments are translated into specific assumption statements. The debate may focus on a few questions: (i) who should assign values to scenario-variables (scientists, user, policy-maker, panel of experts, a socio-economic model)? In the Netherlands, scenario-variable values are selected by a Commission, including representatives of the Central Bureau of Statistics, planning agencies, and government agencies; (ii) how should values be assigned (common practice, Delphi technique, random number generation, educated guess, crystal ball?); (iii) how often should values be adjusted (ie. how often should forecasts be updated?); the answer lies between no adjustment at all, to a highly-developed monitoring system); (iv) which values should be assigned (extrapolation, most likely values, desired values)?

Model Implementation

In her contribution to this conference, Pack (this volume) lists a few conditions that must be satisfied for a smooth implementation of a policy analysis or forecasting model. Similar conditions are discussed by Brooking and Hake (1979) in their paper on the adoption of models for economic policy analysis. A major factor is the environment of the client agency and the model. Pack found that most important for the decision to adopt a model was the presence on

the agency staff of an energetic model enthusiast, who would advocate the model within his organization. She places the main determinant of acceptance or rejection outside of the model characteristics. Some scientists, eager to do socially relevant research, and to see their intellectual product be integrated in planning practice, may be frustrated by this fact of life. There are, however, some limiting conditions that must be satisfied before model adoption can even be considered. One of them is data availability.

The lack of adequate statistical data is frequently given as a reason for not adopting advanced techniques for policy analysis and forecasting. Data limitations are severe for multiregional models which require knowledge of interregional flows by origin and destination. The choice may be between less advanced, ie. less realistic models and the estimation of missing data. The estimation of spatial interactions has interested scientists for many years (for a review, see Nijkamp, 1979). The gravity model, entropy and biproportional adjustment techniques have been studied and applied extensively. Recently, a new dimension has been added to this estimation problem that may well lead to a complete change in our perception of the estimation problem of spatial interaction data. Spatial interaction data constitute a contingency table. The estimation of missing elements of the table from available (frequently aggregate) information implies that certain assumptions are made on the statistical dependence between the cross-tabulated variables. Recent findings in discrete multivariate analysis or categorical data analysis may fruitfully be applied to describe in explicit and simple terms, the interaction pattern imposed on the estimates by the known information. The quality of the estimates may be increased if one can find a simple expression that relates the interaction patterns in the estimates (and therefore, the values of the estimates themselves) to each element in the set of prior information. The log-linear model of contingency table analysis, developed by Goodman, is such an expression. Bishop, Fienberg and Holland (1975), and Goodman (1978) provide good discussions of the analysis of contingency tables. This observation could have even a greater impact on spatial interaction modelling than Friedlander's (1961) paper on the estimation of contingency tables when marginals and some supplementary data are known. Willekens (1980b) shows how the gravity model, the entropy model and the biproportional adjustment model relate to the log-linear model. The parameters of each of these models are also related. The functional form of this relationship is a valuable aid for the statistical interpretation of the parameters.

The relationship between conventional spatial interaction models and Goodman's log-linear model also enables the analyst to answer the question whether additional prior information may be expected to increase the accuracy of the estimates substantially. This is of particular relevance for the decision process in terms of

which data generation technique to adopt (survey or non-survey), since the contribution of each piece of information to the final quality of the estimates (goodness-of-fit) can be quantified. For instance, Willekens, Por and Raquillet (1979), in a report on the estimation of age-specific migration flows from aggregate data show how additional prior information affects the estimation accuracy. The log-linear model helps to explain why. Data limitations will always exist, and data collection will always be costly. If we focus on gaining substantial insight in estimation procedures instead of on developing more complex techniques, we may find an efficient way to determine a minimum of prior information that is necessary to obtain estimates of an acceptable level of accuracy.

CONCLUSION

The systems approach in urban and regional planning and policy-making is evolving rapidly. New modelling perspectives are being developed in response to the demand for realism, diversity and consistency in describing complex phenomena and processes. This paper compares the approaches to modelling systems of regions and elaborates on a few fundamental issues. The paper discusses theoretical, methodological and organizational aspects of the selection of models for planning purposes. The multiregional approach is being proposed as a strategy to deal appropriately with several "hot" issues in modelling systems of regions. There is, however, a warning. Models may help to clarify issues and problems, and may pave the way for their solution by decomposing a problem into its components, and by focusing a discussion on key items. Models will not, however, solve all problems; they will never be able to replace completely human intuition and common sense.

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