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WORKING PAPER NO. 5

THE ECONOMIC EVALUATION OF RESIDENTIAL BUILDING CODES: AN EXPLORATORY STUDY

by

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FOREWORD

This study is one of a series commissioned by the Economic Council's Regulation Reference which deals with various aspects of land use and building codes regulation. These studies do not cover the whole field of land use regulation but they do focus on important areas of concern.

The following is a list (alphabetically by author) of land use studies to be published in this series:

Dale-Johnson, David, Land Use Regulation in Metropolitan Vancouver.

Eger, A.F., Land Development Risk and Regulation in Montreal, 1966-1979.

Hamilton, S.W., Land Use and Building Codes: The Regulatory Framework.

Hamilton, S.W., Land Use and Building Codes Regulation: Summary Report.

McFadyen, Stuart and Denis Johnson, Land Use Regulation in Edmonton.

Proudfoot, Stuart, Land Use Regulation in Metropolitan Toronto.

Seelig, Julie H., Michael Goldberg and Peter Horwood, Land Use Control Legislation in the United States -- A Survey & Synthesis.

* Silver, Irving R. assisted by Rao K. Chagaralamudi, The Economic Evaluation of Residential Building Codes: An Exploratory Study.

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- at the Canadian Home Manufacturers' Association, Mr. Bill Percy, Executive Vice-President.

CONTENTS

Résumé

La principale justification des codes du bâtiment résidentiel se rattache au concept économique des coûts de transaction, c'est-à-dire à ce que valent pour chaque consommateur les renseignements sur la sécurité, la santé et les commodités découlant des caractéristiques physiques du logement. La prescription d'un code du bâtiment peut causer d'importantes distorsions, tant dans la proportion du budget consacré au logement que dans les caractéristiques physiques des maisons construites. Les codes peuvent se justifier pour des raisons d'externalités, comme le voisinage et autres effets intertemporels, de même que pour des motifs sociaux de nature altruiste. Toutefois, trop peu de considération a été accordée aux autres moyens pouvant réduire de telles déséconomies éventuelles. Du côté production, les codes du bâtiment ne sont peut-être pas sans influer sur la productivité. Les codes uniformisés, particulièrement, peuvent favoriser les grands entrepreneurs, tandis que les codes en général peuvent contribuer à répercuter les coûts des constructeurs sur l'ensemble de la société. Il en résulte que certaines économies d'échelle apparentes peuvent n'être en réalité que le résultat de cette forme de réglementation.

Comme elle enlève aux parties à la transaction

immobilière, la responsabilité directe d'assurer la sécurité voulue, les exigences des normes minimales peuvent conduire à des distorsions. Les entrepreneurs en construction auront tendance à diriger leurs activités créatrices dans des initiatives qui échappent aux codes, comme certains travaux superficiels de décoration, plutôt que vers la sécurité. Ce n'est que lorsque les codes sembleront faire oeuvre de discernement entre les divers producteurs que l'on recherchera activement des changements. Le remplacement des codes locaux -- qui constituent une sorte d'obstacle à l'accès au marché -- par des codes uniformisés est le résultat d'une telle réaction. La répartition des responsabilités entre les divers paliers gouvernementaux, pour la formulation et l'application des codes, comporte un choix entre, d'une part, la réalisation d'économies d'échelle résultant de cette formulation et de cette application et, d'autre part, la liberté des personnes de choisir leur propre degré de sécurité résidentielle. Quant aux distorsions causées par les codes du bâtiment en faveur des producteurs, elles sont peut-être plus graves lorsque la formulation du code est du ressort provincial.

Pour être satisfaisante, une évaluation des avantages et des coûts des codes du bâtiment nécessite d'importantes recherches supplémentaires sur plusieurs aspects : la volonté des consommateurs de payer pour la sécurité des logements; les effets des règlements de construction sur les approvisionnements; les solutions du rechange au système actuel et la mesure du degré de sécurité dans le domaine du logement.

S U M M A R Y

The primary rationale for residential building codes is related to the economic concept of transaction costs - the individual consumer's price of information about safety, health and convenience stemming from the physical properties of the dwelling. The imposition of building code requirements may lead to significant distortion, both in the proportion of the budget allocated to housing and in the physical characteristics of housing constructed. Building codes may be justified on the basis of externalities, particularly neighborhood and intertemporal effects as well as altruistic social concern; however, there appears to have been little serious consideration given to alternative means for reducing such potential diseconomies. On the production side, building codes may not be neutral in their effects on productivity. Uniform codes, in particular, may favor large-scale builders, while building codes in general may shift costs from builders to society as a whole. The result is that apparent scale economies may be largely an artifact of this form of regulation.

In removing direct responsibility for the provision of safety from the parties to the housing transaction, the requirement

of minimum standards may lead to biases. Builders will tend to channel their innovative energies into types of activities which are not in the domain of codes, e.g., superficial decoration, rather than safety. Only where codes appear to discriminate among producers will changes be actively sought. The transition from local codes, which present a form of market entry barrier, to uniform codes is the result of such a reaction. The division of responsibilities among governmental jurisdiction in code formulation and enforcement involves a choice between the capture of scale economies of formulation and enforcement, on the one hand, and freedom of individuals to choose their levels of residential safety, on the other. With respect to biases introduced by building codes in favor of producers, these may be aggravated by formulation at the provincial level.

A satisfactory evaluation of the benefits and costs of building codes requires considerable further research in several areas: consumers' willingness to pay for safety in housing; the effects of building regulation on supply; alternatives to the present system; and the measurement of safety in housing.

Chapter 1: Introduction

A. Objectives of this Study

Housing and its environment are the subjects of a wide variety of public planning and control functions affecting health, safety, safeguard of property and amenity. The broad question to which this study is addressed is whether the allocation of resources to the promotion of the ends which this complex of regulation is intended to serve is optimal, or whether alternative configurations, involving possible combinations of public control and guidelines and private market arrangements may be more efficient (in Pareto terms).

In order to keep the study within practical bounds it will be limited to a consideration of building codes per se, and within that category to residential building. Other studies being undertaken concurrently under the Economic Council's Regulation Reference deal with various aspects of development regulations. In future, studies might usefully be undertaken in which the broader complex of regulation would be investigated in an holistic framework. This study is a partial one in the sense that it treats only building codes and considers alternatives which may serve to promote the ends for which building codes are designed. Furthermore, as indicated by the title, this study is exploratory. Very little investigation has been performed on building codes from an economic viewpoint, although many technical-engineering studies are available.

The objectives of the study are both to describe the institutional setting and recent evolution of residential building codes in Canada and to identify the economic issues surrounding building code regulation. The method to be employed in examining these economic issues is the applied welfare economic technique known as benefit-cost analysis*. We believe the resulting type of framework is the best way of organizing further research. The technique normally involves a comparison of two or more courses of public action wherein one of them is treated as the base alternative and the consequences of the others are expressed as differences from this base. Most commonly, a specific project or program is compared with a status quo policy. The various consequences are arrayed in terms of their net additions to or subtractions from aggregate income of the relevant population - with a suitable discounting of the expected differences of the future streams of income by means of a social discount rate. In addition, the effects of the alternative courses of action are sometimes appraised with respect to their impacts upon the redistribution of income. These redistributive effects may be compared, by the responsible public jurisdiction, with those pertaining to the efficient (from the point of view of aggregate income) allocation of society's resources for

* Only the main features and most significant problems associated with benefit-cost analysis can be included in this discussion and then only in the most cursory fashion. A standard reference for a comprehensive review is Prest and Turvey (47). More recent methodological discussions have been produced by Mishan (48) and by Treasury Board Secretariat (49).

the purpose of making a choice among alternatives. The most clear-cut, and consequently the most common type of application of benefit-cost analysis is in the evaluation of large-scale public investment projects. The most significant elements of benefits and costs and their time-profiles of realization are relatively easily identified and evaluated in comparison with a no-action alternative. Impacts on relative prices of resources where significant are usually at most tranistory and localized.

In the case of building codes, the impacts of public action and their evaluation are not so clear-cut. First, the "base case", if it is to be taken as the status quo, is the one in which the public program is, and for some considerable length of time has been, in effect. The direct comparison with one or more outcomes which might result from a "laissez-faire" policy in this area would involve some speculation as to alternative means which might be employed - through market or quasi-market mechanisms - for achieving the ends which the public policy now serves. Consistent with the previously-stated limitation of the study to building codes, an assumption regarding compensating changes in other related instruments of public policy would have to be made. For the treatment of individual consumers and private-sector institutions, reasoning would have to be developed about their behaviour. A problem in proceeding from theoretical reasoning to evaluation is the lack of any but the most indirect evidence on individual preferences outside the context of the ubiquitous building codes.

In this study, we shall compare the situation which prevails under the present building code system with what might be expected under a market-oriented system. The base situation is such as we might expect to develop in the absence of codes, but in the presence of other restrictions imposed by government. This hypothetical situation includes compensating alterations in existing governmental regulations intended as substitutes for achieving some of the same objectives as building codes. For instance, the absence of building codes might result in smaller rooms, less fenestration, etc., which might in turn result in more stringent occupancy and fire code provisions, or more stringent enforcement of existing provisions. These would become the effective constraints to conditions of unhealthy dwelling conditions which in part are now prevented by the structural constraints of building codes. It is to be expected, however, that

consumer demand for structural features, faced with a market-determinded schedule of house prices versus structural features, might effectively prevent transgression of what are now legally enforceable requirements. Since new and renovated housing, even in the absence of building codes would continue to be purchased by middle and upper income households it might be expected that the characteristics of such housing with respect to health and safety would not diverge greatly from levels mandated by building codes - which are meant to express societal norms - so long as consumers are aware of the relationship at the margin between the price of housing and safety and/or alternative mechanisms are established which provide incentives to builders for incorporating safety features in the dwelling. Making builders liable for death, injury and adverse living conditions resulting from unsound construction, for instance, would provide such incentives. The existing home warranty system is a step in this direction, but its purview might be greatly enlarged*. We shall assume that such a system

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* There is precedence for such an extended system. In France, there are no comprehensive building codes. Designers and contractors are liable for a ten-year period for major defects and for two years for minor defects. Liability insurance is therefore almost universal in the industry. A condition for obtaining coverage is adequate technical supervision of design, workmanship and building products. Thus, "the practical effect of the requirements of the insurance market is comparable with building control systems elsewhere" (39).

of primarily market-determined constraints against unsound building practices would be part of the base situation. Resources would be devoted, under such a system, to many of the same types of activities as now occur in connection with building codes - materials testing, inspection, etc. Only as the result of considerably more theoretical and empirical analysis would it be possible to make estimates of the extent of resource reallocation under a specific combination of market-oriented and regulatory mechanisms. For the purpose of this study, such gross figures as we have been able to assemble, pertaining to the prevailing building code system may be compared with directions of change resulting from building codes. Some suggestions will be offered as to more rigorous quantification.

Alternative approaches to the evaluation of building code impacts were considered but rejected. First, a comparison might have been made of the benefits and costs, within a prevailing system of building codes, between the near-uniform set of provincial codes which has evolved in the past few years and the previous system of locally formulated codes strongly related to the National Code. Much of the concern expressed about building regulation has been related to the efficiency aspects of anomalous provisions in various municipalities. Such a comparison would have the advantage of being based upon two explicit legal frameworks. On the other hand, such anomalies as did prevail up to end of the Sixties

were relatively minor, at least in terms of the populations directly affected; whereas variations in code enforcement, about which adequate evidence is difficult to establish, may have been much more significant and may not be corrected by mandatory uniform codes alone.

These two types of systems may, in any case, be compared within the framework, the basis for which we hope to establish, by comparing each with the base situation. The present study will include a discussion of the background and possible effects of mandatory uniform codes. The discussion may serve as a basis for judging whether this recent innovation significantly alters the net benefits of building regulation.

Another alternative, benefit-cost analysis "in the small," would seek an evaluation of the marginal effects of adding, revising or deleting specific code provisions. A beginning at methodological studies along this line is being made at DBR and at the U.S. Bureau of Standards (35). While this type of approach may have merit for operational purposes, it is directed at ascertaining impacts within the existing regulatory system; whereas we are obliged to examine the impact of the regulatory system itself.

B. Historical Background

Under the terms of the British North America Act, provincial governments have broad responsibility for public safety. In the past, they have regulated directly such elements of construction as pressure vessels, elevators and plumbing systems. Until recently, however, the regulation of building construction has been delegated to municipal governments. This approach has had the advantage of allowing individual communities to impose their own norms, and to deal directly and explicitly with variations in environmental and other variables affecting cost in relation to level of safety and convenience. In practice, the high potential costs of obtaining information and formulating codes to deal adequately with the complexities of building resulted in great unevenness in the technical content and sophistication of such codes. Smaller municipalities, in particular,were able either to formulate only sketchy and incomplete codes, or copied sections or entire codes from larger municipalities.

In the mid-Thirties,with the introduction of a National Housing Act, the idea of a "model" National Building

Code to promote more rational, uniform bylaws was first conceived. "The Code was envisaged as an advisory document to be prepared by representative national committees utilizing the best technical and professional skills"(1)*

The first National Building Code (NBC), prepared under the joint auspices of the Department of Finance (then administering the National Housing Act) and the National Research Council, was issued in 1941. While adoption was slow during the war years, the NBC's requirements were reflected in varying degrees in the bylaws of over 200 municipalities. By 1974, over 70 percent of the population resided in areas where the National Building Code had been voluntarily adopted as the local building bylaw or formed the primary basis for it.

In 1947, the National Research Council took steps both to strengthen the technical basis and to formalize the consultative process among public and private interests for code formulation. A Division of Building Research (DBR) was established, which has since become the largest of NRC's eight laboratory divisions, and "the largest and most diversified laboratory complex in Canada" (1)** A new committee, the Associate Committee on the National

*Numbers in parentheses pertain to items in the list of references at the end of this paper.

** A more detailed account of DBR's history and activities may be found in (41)

Building Code (ACNBC) was appointed. The Committee is responsible for the content of the Code, while the Division provides technical support. Under this arrangement, the second edition of the NBC was produced in 1953, as were subsequent editions in 1960, 1965, 1970, 1975 and 1977. Members of the Committee are appointed as individual specialists rather than as representatives of the interest groups with which they may be affiliated. A related committee is the Associate Committee on the National Fire Code which is responsible for the preparation of the National Fire Code - a model fire prevention bylaw.

During the decade of the Seventies, a major trend in responsibility for the formulation of building bylaws has been away from the municipalities to the provincial level. One factor, at least, in stimulating this trend was the costs faced by large-scale builders in dealing with a number of local jurisdictions with varying regulations. British Columbia, Alberta, Manitoba and Ontario all have mandatory codes. Municipalities in these provinces are obliged to enforce a uniform code, without exception or addition. In Quebec, small residential structures are exempted, but municipalities which formulate their own codes adopt provisions for such structures at least as stringent as the provincial code. In B.C., Vancouver, as a Charter City, is exempt, but has in fact adopted the NBC. In Saskatchewan, municipalities have the right to amend the provincial code. A mandatory code has been adopted

by Nova Scotia's government, but not yet proclaimed. In New Brunswick, municipalities are required to adhere to the NBC. In Prince Edward Island, the two major urban areas use the NBC as their bylaws. In Newfoundland, the provincial government encourages all municipalities to adopt the NBC as the basis of their bylaws. In all cases where provincial codes exist, they are based upon, and follow closely the NBC (55).

C. Rationale and Structure of the National Building Code and Relation to other Housing Regulations

i. Scope

The primary purpose of the National Building Code, as stated in the prologue to the document published by the Associate Committee, is "the promotion of public safety through the application of appropriate uniform building standards throughout Canada" (4, p.xi). It is described as "a set of minimum regulations respecting the safety of buildings with reference to public health, fire protection and structural sufficiency".

The Code applies "to the design, construction and occupancy of new buildings, and the alteration, reconstruction, demolition, removal and relocation and occupancy of existing buildings". It should be noted that for existing dwellings, portions of the Code associated with substantial costs of production, i.e.,

structural and material features, do not pertain, as long as the structure is not moved.

The body of the NBC contains seven substantive parts:

Part 3: Use and Occupancy - contains requirements with respect to health and fire safety, which depend upon the use to which a building is put and its type of occupancy. Individual sections deal with subjects such as: size and occupancy requirements for fire safety (distance between buildings, access for firefighting equipment, etc.); safety requirements within floor areas (fire separation between dwelling units, etc.); and location, size and other characteristics of exits.

Part 4: Design - deals with loads to be used in design calculations, foundation design and construction, and design requirements specific to the use of wood, masonry, concrete, steel and aluminum.

Part 5: Materials - specifies that only approved materials may be used, but that other materials equivalent in quality, strength, effectiveness, fire resistance, durability and safety may obtain approval subject to testing or other evidence.

Part 6: Building Services - concerns the safe functioning of heating, ventilating, elevator and other service equipment.

Part 7: Plumbing - incorporates by reference all technical requirements for the size and quality of fixtures and related pipes and fittings for plumbing systems.

Part 8: Construction Safety Measures - deals with public safety at construction sites.

Part 9: Housing and Small Buildings - provides detailed requirements for the construction of houses and small buildings of up to 6,000 square feet per floor and three storeys in height. The residential provisions of this Part, combined with additional requirements for durability and performance make up the Residential Standards, used by Canada Mortgage and Housing Corporation (formerly Central Mortgage and Housing Corporation) to govern construction under the National Housing Act.

The above recitation of the nature of the NBC does not adequately convey the complexity of the Code as a document. The 1977 publication contains over 360 pages of closely-set text, in 79 sections. In addition, a number of separate codes and standards as well as supplements to the NBC itself are incorporated by reference. *

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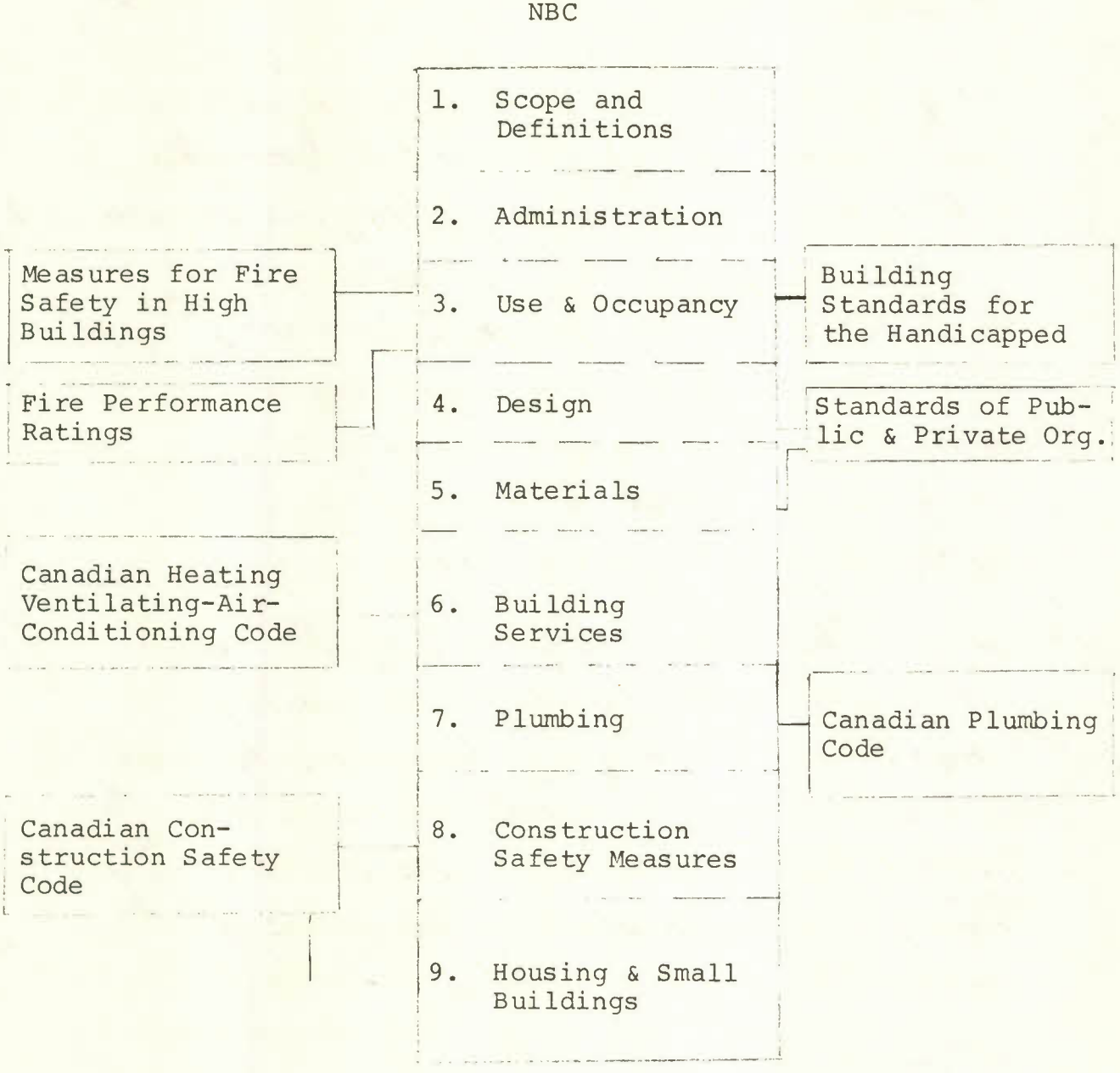
* Standards are written by a number of public and private organizations (70, p.95). These include Canadian Standards Association, Canadian Government Standards Board and Underwriters' Laboratories, among others.

The relationship can be illustrated by the following diagram.*



* A number of changes in this structure are to be made in the 1980 Code. For instance, the Heating Ventilating and Air Conditioning Code will be incorporated into Part 6. The Code for Construction Safety will be discontinued, and the requirements pertaining to public safety will be incorporated in the NBC.

ii. Related Regulations

The scope of building codes should be distinguished from other regulations directly affecting the characteristics of housing and its occupancy.

- Housing maintenance codes set minimum standards for safety, health and welfare of housing occupants. By contrast with building codes, the emphasis of housing codes is on the occupancy of existing dwellings, rather than with the structural requirements which must be met in new construction, conversion and renovation. Housing codes cover three main areas (20, p.274):
  - -- facilities to be supplied, such as toilet, bath, sink, etc.;
  - -- level of maintenance, structural and sanitary, such as leaks in roofs, cracks in walls, etc.;
  - -- occupancy, concerned with usability and amenity of interior space, especially in terms of number of people who may occupy dwellings and rooms of different types and sizes.
- Development standards are regulations for controlling physical development, including building types allowed, minimum lot sizes, infrastructure and site preparation requirements, etc. These standards are embodied primarily in zoning ordinances and subdivision regulations.

As with building codes, housing codes and development standards have associated with them a number of supplementary sets of standards and regulatory instruments, including site design regulations, health and sanitation codes, flood control ordinances, trailer ordinances, etc. Taken together, this system of legal regulatory instruments affects all aspects of the dwelling and its physical environment, as well as many aspects of residential activity.

Related to these codes and standards as part of the general framework of control over development are a variety of so-called "public guide instruments" (20, p.313). These include both the community comprehensive plan and a variety of other plans frequently oriented to the requirements of Federal or Provincial programs, such as Neighborhood Improvement Plans, residential rehabilitation plans, etc. These instruments may be characterized as being indicative of the goals desired by the community and the means, through public and private action, by which it is intended that they be accomplished*. Such plans may be supplemented by specifc designs for projects to achieve the stated goals, such as infrastructure projects in support of residential rehabilitation. The administration of the

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* See Ferguson (42) for an extensive discussion of the relationship between urban planning and building codes and standards.

entire system of environmental controls and services accounts for a very large share of the resources available to local and regional governments*.

In addition to the formulation of uniform departures from individual regulations of the NBC) provincial governments attempt to control standards of construction indirectly through the registration of architects and engineers.

In the private sector, also, there is at least a potential for enforcement of sound building practices through the requirement of mortgage lenders for property insurance. In the case of housing constructed under the National Housing Act, Canada Mortgage and Housing Corporation reviews building plans and inspects construction-in-progress for confromance with the Residential Standards. For housing not associated with any social housing program (federal or provincial) however, and with the exception of large, multi-unit developments, insurance firms are passive, in the sense of granting coverage alsmost automatically, as long as policies conform with generally-accepted insurance principles, e.g., policy value consistent with replacement value. Rate which reflect risk, classes, and their corresponding premiums are based upon past experience with type of construction, adequacy of public fire protection, etc. This passive role of insurers, it

* For calendar 1977 municipal expenditures on protection of persons and property, sanitation and waste removal, health and environmental development amounted to $4.5 billion, 23% of the total, and 40% of the non-educational budget.

might be surmised, is the direct result of the active public enforcement of the complex regulations described above.

D. Problems of Evaluation

i. Allocational versus distributional effects

In principle, the application of benefit - cost analysis is directed to evaluating change in well-being of individuals in the relevant population. In practice, because no generally accepted criterion is available for aggregation, the simplest measure is usually employed, i.e., change in total income of the population. In addition, consideration is usually given to the income distribution effects of the change, although the latter are rarely treated as extensively and as rigorously as the former. In the case of building codes, however, these distributional effects are important. They may even outweigh considerations of efficient resource allocation. Much of the impact of codes relates, as will be discussed in this study, to externalities at interpersonal, neighbourhood and jurisdictional scales as well as intergenerationally. Moreover, building codes have a variety of outputs. Even if we can establish a set of groups in the population - low income renters, high income purchasers of new dwellings, small builders, etc. - who are relatively homogeneous with respect to one or another output, there may be significant differences with respect to the whole range of effects, hence the dimensionality of the analysis makes it unmanageable.

In the present study, we shall confine ourselves to the more modest objective of identifying the major sources of distributional impacts and those groups which would appear to be most prominently affected.

ii. Relevant Population

A universal problem in benefit-cost analysis is the choice of a relevant population. Initially, the entire population of Canada would appear to be appropriate, since housing services are consumed by all persons. It must be noted, however, that any change in building codes affects directly over a short period of time only a small proportion of all households, i.e., those consuming housing services (whether through rental or purchase of the property) of newly-constructed or newly-renovated housing. Largely because of the external effects of building safety, however, both of a pecuniary and of a psychic nature, significant impacts on the level, and change in the level over time, of residential safety are spread significantly to the remainder of the population. Furthermore, and in spite of variations among jurisdictions or among provinces (depending upon the type of building code system), building codes represent a national policy based upon a common set of concerns. These include the expectation by individuals generally that any dwelling they choose in future to occupy be adequately safe for themselves, and that the same hold true for all other members of the society. Accordingly, we shall assume, in this study, that the relevant population is the entire population of Canada.

iii. Intertemporal effects and discount rate

The next problem results from the fact that the effects of building codes extend over a long period of time from the point at which they are implemented, i.e., in the course of initially constructing or of substantially renovating a housing unit. The housing unit is long-lived. It normally contains many households over the course of its existence. Occupancy by these households, because of change of dwellings or dissolution, is more or less transitory. Building code provisions also change over time; but because most of the structural features specified in building codes cannot be altered to conform with current standards except at a cost which society is not collectively prepared to bear, these "obsolete" dwellings, by and large, remain until their replacement becomes economic or until they become so unsafe due to inadequate repair and maintenance, that they are condemmed. For any short period of time, only a very small share of dwellings are affected by code changes, e.g., about 3% in a year. The result is a changing matrix of households of a variety of socio-economic and demographic characteristics re-arranging themselves among housing units of a range of safety levels, only some small share of which may correspond with current norms for safety in new construction.

This pattern may be further complicated in at least three ways. First, where safety requirements, though changing, vary consistently among local jurisdictions, (both through

code formulation and enforcement) even households occupying new housing in some jurisdictions will not enjoy levels of safety as high as those in others. They will be "behind" the latter (assuming constantly rising levels in all jurisdictions) by an amount corresponding to the lag in "upgrading" i.e., making regulations more stringent, by the former compared with the latter jurisdictions. Thus, if we examine all those households enjoying some particular level of safety in their dwellings (abstracting from difficulties of measurement of safety) their housing will vary in age.

Second, building codes address the problem of safety in dwellings only in terms of the structural features of the newly-constructed or newly-renovated unit. Changes in building codes may reflect changing living conditions (the "technology of consumption") and the consequent changes in provisions required to maintain a given level of safety. Increased use of appliances, for instance, calls forth changes in electrical requirements. Similarly, changes in the technology of providing safety are reflected in new requirements or allowances for materials and structural elements or their performance. Over the long lifetime of the housing unit, however, the level of safety which it provides may be eroded

by inadequate levels of maintenance and repair, overloading of the dwelling's sub-systems or generally dangerous living habits. Safety may also be increased, of course, as by installing higher-capacity electrical systems, etc., but the possibilities in this direction seem to be more circumscribed with existing technologies.

Third, the level of safety yielded by a housing stock with a particular distribution of physical characteristics may vary over time according to the aggregate demand related to it. In a period of sustained income growth and declining family sizes, for instance, the ratio of persons per room might decline, at least as the housing stock approaches a long-run level. This pattern of occupancy, leaving aside living habits which might change concomitantly, would probably tend to increase safety.

These considerations of the influence of use of the housing stock on the efficacy of building codes in achieving safety lead to a consideration of the reverse influence: that of building codes designed to promote safety upon the useful lifetime of items in the housing stock - the length of time during which each dwelling or structure in the housing stock

provides services, including safety, which do not fall below some minimum acceptable quality level*. Forces that prolong the useful life of structures generate benefits; those which shorten useful life generate costs. A distinction may be made between depreciation and obsolescence, the two general processes that determine the useful lifetime of capital. The rate of deterioration of the physical condition of housing over the course of its existence as well as of the pattern of its use are determined in part by the stipulations of building codes as they apply to original construction and renovation. Obsolescence, on the other hand, is a capital-enhancing process, which results from technical improvement. It adds units of greater safety and amenity to the housing stock without decreasing the quality of older units.** Acceleration of obsolescence implies a more useful stock of capital; acceleration of depreciation, a less useful stock.

These considerations raise the question of an appropriate discount rate for calculating benefits and costs. The impacts of building codes are distributed over time, and

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* This discussion draws upon Rothenberg (43, p. 106)

** Throughout this study, we shall refer to the component outputs of housing as falling into two categories. "Safety" comprises "health, fire protection and structural sufficiency" - the province of building codes. "Amenity" covers the remainder of services provided by housing and associated with comfort, convenience, aesthetic qualities, etc.

different types of building code systems may yield different time profiles of benefits and costs relative to the reference case. A problem of sometimes major concern to benefit-cost analysts is which rate to choose. This choice may determine the ranking of alternative policies, including the reference case. In the briefest possible terms, we would presume that a thoroughly-quantified analysis would employ a social, rather than a market rate of discount. The direct effects, i.e., those impinging on occupants of new and renovated housing, via construction costs, on the one hand, and safety, on the other may be the most apparant. As we have indicated above, however, the benefits of building safety are spread through society. The reason why time is important in evaluating building regulation is that it is intended, at least, to move the entire housing stock into conformance with social preferences for safety and to reflect the changing characteristics which a dwelling must embody to maintain a given level of safety, because of the changing technology of use. In addition, certain social resources are effectively committed as part of the building code system, including R& D, testing, administration related directly to codes, as well as complementary services such as fire protection.

Chapter 2: Safety in Dwellings

A. Consumer Behaviour

i. Demand for Safety

The concern most prominently associated with residential building codes is the need to provide an adequate level of safety in dwellings.

The complexity of modern building methods makes it unlikely that the prospective homebuyer or renter, or, indeed the great majority of landlords, who own and frequently share occupancy of small muti-unit structures, will have sufficient technical knowledge to judge the structural soundness and other physical aspects of the building affecting safety of occupancy. Building codes are intended to provide a minimum level of quality. It is assumed that, in the absence of such standards, builders would provide, in housing, quality levels consistent with returns. Faced with a choice among features affecting safety and others primarily related to convenience or "cosmetics" builders would attempt to strike a balance in the composition of features such that marginal returns are equalized. Since the more superficial (from the point of view of safety) features of the structure are also more apparent to the consumer, much of new housing construction and renovation would be less safe than the consumer would choose with better information.

The relevant question is whether building codes, which are

based upon centralized information generated by the public sector, lead to an optimal housing bundle. Even though information may be generated centrally at costs much below those which would be associated with individual effort, such costs might nevertheless be excessive in comparison with what individuals would be willing to pay, as their share, for the presumed increase in safety.

The problem may be summarized graphically as in the figure below.

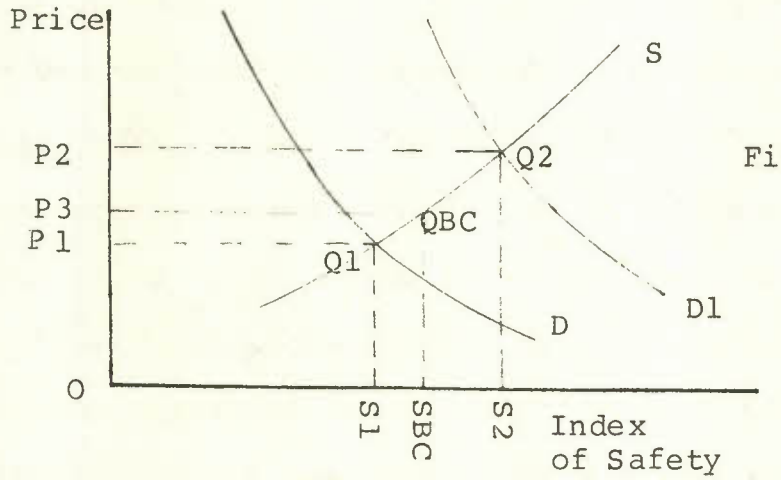

Figure 1

Suppose that "safety" can be measured by a single, continuous scale which would combine such elements as probability of death and injury and expected value of property loss, and that safety is entirely separable from shelter and amenity features. Assume also that the value of this index could be altered by the builder without altering other qualities of the dwelling affecting its utility, i.e., the amenity and safety aspects of the dwelling are separable. The marginal costs of increasing levels of safety are repre-

sented by the curve S. If each consumer were left to form a judgement about the safety level of a dwelling, his demand curve might look like D. He would be paying an amount represented by the rectangular area 0-P1-Q1-S1 for safety features in the dwelling, in addition to the payment required for information. If information on safety were costless, the consumer's demand curve might be shifted to D1. The reduction in the price of information to zero would increase his income, and part of his expanded budget might be allocated to safety as well as more amenity and non-housing goods. Furthermore, the complete knowledge of the safety attributable to the dwelling's features might incline him to purchase additional such features from a fixed budget. His total expenditure on safety would correspond to the rectangular area 0-P2-Q2-S2. Of course, his demand curve might, instead, move to the left. Precise knowledge of the safety level associated with various building features may, depending upon his willingness to accept risk, make him more inclined to accept a set of loss probabilities than in a situation where such probabilities can only be poorly evaluated. The vertical dashed line BC represents the level of safety corresponding with building code minimum requirements. Assuming builders provide only these minimum allowable features, the consumer pays an amount corresponding with 0-P3-QBC-SBC for safety features. Depending upon where the building code constraint is placed on the horizontal axis, this expenditure might be greater or less than either of the amounts related to P1 and P2, or fall somewhere in between (as shown). It

must be noted that the formulation and enforcement of building codes is not costless. Thus, in addition to the sum P3 x SBC there is the individual consumer's share of social costs related to the provision of safety. Furthermore, even with a system of building codes, no matter how scientifically based, the consumer might demand safety features in addition to the minimum requirements of the building code and this additional consumption might entail information costs, e.g., in hiring an independent architect to advise on some aspect of the builder's design.

The primary rationale for building codes is related to the economic concept of transaction costs - the individual consumer's price of information about safety, health and convenience stemming from the physical properties of the dwelling. He is therefore forced into a tradeoff between greater expenditure on his dwelling and assuming a risk the level of which may be high. The imposition of building codes, it is asserted, involves a sufficient saving of resources in establishing the safety level of various building features (as well, possibly, as savings from induced efficiencies in construction) to compensate the consumer for any resulting constraint in choosing the features of the dwelling he purchases or rents.

The central problem in the evaluation of building codes is to ascertain whether the increased level of safety resulting from the system, as the result of reduced costs of acquiring information about the effect of building features on safety, and other, indirect benefits would be sufficient to compensate all consumers in society for the additional costs - direct and indirect - which result from the code system. It is possible, as should be clear from the above discussion, that consumers might indeed choose greater expenditures and higher levels of safety in the absence of building codes, but with the existence of the knowledge generated by the building code system, than actually obtains under such a system. The criterion for evaluation of building codes would be unchanged. The lesser resources devoted to structural safety features and to obtaining information under the building code system must be sufficient (in combination with indirect costs and benefits) to compensate consumers for the reduction in safety which prevails.

This criterion is based upon the assumption, which in turn involves an ethical judgement, that individual preferences are to be accepted as the measure of changes in well being. Such preferences may be revealed in a market situation, in which consumers voluntarily relinquish money income for some real commodity or service. Where such transactions do not occur, the money value which would be placed on a

hypothetical transaction must be employed. Insofar as no individual is certain, in advance of consumption, how much psychic enjoyment he will realize from the object acquired, all transactions involve the assumption by the individual of risk. That the risk involved pertains, not to disappointed pleasures resulting from failure of a gadget to perform according to expectation, lack of sunbathing due to poor weather, etc., but rather "earnest" matters such as loss of property, injury and even death, does not alter our method of inference.

The benefits and costs of a public policy such as building codes are, where possible, to be evaluated by comparison with the values which a person places upon goods in the marketplace. These values are expressed by the amounts he purchases at specific prices. In the case of non-market goods which are "available" in fixed quantity, he must be presumed to be willing to place upon such goods or "bads", an evaluation in the form of an amount of income he would be willing to sacrifice or receive, respectively, for their consumption or avoidance.

ii. Empirical considerations

There are a number of abstractions in the above exposition which, while they may be appropriate for presenting the main theoretical points, require further consideration for an empirical study. These points will be mentioned here and given further treatment in the course of the study.

First, we have assumed a scale of safety related to physical features of the dwelling. Even if information were costless (corresponding to the D1 curve in the diagram) perfect foresight is impossible. It is impossible to know, e.g., that a particular structural member will fail at a specific point in the life of the structure. Science can, at best, provide us with probabilities, in terms of expected durations of performance, and conditional consequences (14, p.9). Building codes are based upon, e.g., the resistance of material to flame spread. This is a measure which indicates how long a component will resist the spread of fire, contingent upon being exposed to fire. Such information,whether available as the result of the building code system or otherwise, would still require a judgement as to whether the component would indeed be subjected to fire which, again, can only at best be expressed as a probability.

Information is not, in reality, costless to acquire. For building safety, a precise relation between differences in specific configurations of building components with particular dimensional and material characteristics is not available. The reason is that adequate testing, either in a laboratory environment or by using existing structures as experimental subjects would appear to be prohibitive, considering the presumed value of the information to be obtained. Because of the vast number of components

included in a dwelling, the potential number of prototypes incorporating what might be assumed a priori to embody significant differences in safety and/or corresponding to different "models" actually found in the marketplace and which would presumably require destructive testing would be very large relative to the number of dwellings about which safety "levels" are desired to be established. Furthermore, the probability that fire or structural collapse will occur depends at least in part upon how the dwelling is used, i.e., upon the behaviour of the occupants, and to a lesser extent upon random natural occurrences from external sources. A large share of deaths, injuries and property losses is attributable to carelessness in the use of smoker's materials, overloaded electrical circuits, flammable liquids, etc. Measures for increasing dwelling safety, as stipulated in the NBC and other codes, are to a considerable extent "passive", in the sense that they are designed to reduce the destructive effects on life and property resulting from human failing (mainly fires) and natural occurences (earthquake, lightning, flood, deluge, wind, snow).

The imprecision of estimates of probability of occurrences and extent of loss of life and property may be related to

consumer behaviour through the concept of risk acceptance or, equivalently, risk aversion. If consumers are heavily risk averse, they will place relatively greater value upon avoiding small probabilities of large losses. With limited information, they would be willing to spend more on measures which they believe to reduce loss than they would if their expectation of loss were the same, but perceived as being more precise. This additional expenditure on safety measures may therefore be seen as a consequence of information costs. In terms of the preceding diagram, risk aversion moves the curve D (positive information costs) toward the right, (if the original position is seen as one of risk-neutrality) tending to reverse the positions of the two curves. The converse may, of course, hold. A tendency to accept risk would move the demand curve to the left, corresponding with less expenditure on safety features.

Insofar as households' investment in safety-related features is altered by perceptions of safety, risk aversion and building code minimum standards, it might be expected that their expenditure on pure amenity features might vary in the opposite direction, i.e., that there is a substitution between the two types of dwelling features. This conclusion

must be tempered, however, by the observation that possibilities for substitution are constrained by the physical characteristics and arrangements of structural components. Such reduced expenditures on the so-called amenity features of housing may also play a significant role in counteracting the intent of building codes to increase safety. To appreciate this point, we must drop the assumption of housing features as being neatly divided between those affecting safety and those affecting amenity. Larger and more numerous doorways, for instance, lend convenience to use of the dwelling, in addition to increasing egress in the event of fire. If code requirements increase structural requirements beyond levels which the owner would choose freely, they are likely to reduce his expenditures on furnishings and appliances, among other budget items. These reduced expenditures may work in a direction contrary to enhanced safety if they result in ownership of less well-constructed goods. Of course, under the present regulatory system some of these commodities are also subjected to mandatory minimum standards, especially in respect to electrical safety. It might be surmised, however, that safety levels are positively associated with other aspects of quality in such goods.

An important dimension which allows, within the constraints of building codes, variation in expenditures necessary to meet minimum building code requirements is the choice of structure type, single-family, duplex, row house,etc. Each of these will have a range of costs associated with safety features, depending upon size of unit(s), physical layout, soil characteristics, etc. Among housing types, even holding constant such indices of housing services as floor area, number of rooms, etc., any additional construction costs attributable to building codes beyond those which would be chosen by the owner in the absence of codes may be expected to vary. The different physical arrangements of dwelling units in different structure types make code constraints operative in some but not in others, e.g., party-wall regulations are relevant for row housing but not for single-family structures. The distribution of structure types in the flow of new construction reflects, in part, the reaction of consumers to this variation in safety costs, a component of the price of housing services. It is attempted, through the medium of building codes, to regulate globally features of construction affecting safety. Strictly interpreted, such regulation would involve stipulation of the type of housing allowed to be built, as well as (under the present system) the physical characteristics of building components within a given type of housing. Zoning bylaws

impose such requirements to some extent; but the restriction of all building to the safest structural type would undoubtedly be an unacceptable intrusion on individual liberties in our society.

Since safety and amenity features are to a considerable extent intertwined, raising safety standards has some direct effect in raising the level of comfort and convenience. Nevertheless, by being forced to accept some features, the consumer derives less satisfaction from a housing unit of given price. He might have wished, e.g., to have a narrower and less expensive stairway than required, (which affects safety), and instead to spend more on other features, e.g., "rustic" decoration of the kitchen cabinets (which presumably does not). The constraints of building codes probably tend to increase expenditures on housing, both because many safety-related features also have amenity value and because of complementarity in use between safety-related and amenity-related features.

B. External Effects

The general model as we have developed it thus far has been in terms of an individual choosing some level of perceived safety in his dwelling in relation to budget expenditures on housing features not affecting safety and other objectives. An important part of the rationale for building code regulation, however, is related to external effects - more specifically the external

diseconomies - which it is presumed individuals would inflict upon one another, without compensation, in the absence of such regulations. These external diseconomies are of two main types.

ii. Neighbourhood effects

First, there are "neighbourhood effects." A structure which is fire-prone endangers neighbouring dwellings. A property owner who is willing to assume a high level of risk to himself and, in addition, indifferent to the fate of his neighbours inflicts upon them higher levels of risk, through the spread of fire, than they would assume if he and his "fire-trap" were not in the vicinity, and/or forces them to spend more on dwelling-related safety. The additional expenditure might be on structural features, e.g. installation of much more fire-resistant material in the structural shell. It might also result from locating in areas of like-minded (with respect to fire safety) residents or in low-density areas where danger from fire spread would be less. The latter type of alternative might not entail greater expenditure on the dwelling than in the absence of externalties. Again, the welfare effects of building codes must be evaluated in terms of the "compensating variation": that the household moves as the result of a change in risk, externally imposed, implies it would require some compensating payment to make it equally as well - off as it would have been in the absence of the externality.

This neighbourhood effect also implies that owners of properties in the vicinity of a "high risk" structure would invest less in the maintenance of their dwellings than they would in its absence. The structure of low-level safety makes the others also less safe. While households are potentially mobile, structures can be moved only with substantial costs. Thus, even in the long-run , the presence of a high-risk structure lessens the return to investment in other, high quality structures in the area, since the imposed risk may be expected to be reflected in lower market value for these latter properties. This effect is similar to that of blighted properties in the formation of slums (43, p.40) (57, pp. 106-112).

iii. Intertemporal effects

A second type of externality relates to the long life of the typical dwelling and the importance of the re-sale of market in the distribution of housing services. Most purchases, and to an even greater extent rentals at any point in time are of dwellings which have been occupied previously. Transaction costs associated with information on safety features of the structure are potentially incurred each time it changes occupants. Over the life of the structure the number of such transactions may be very large - on the order of 50 to 100 for rental units in areas of very high turnover. Households move among dwellings within the stock in order to obtain a more suitable set of housing services,

consequent on changes in household size, ages of family members, income, location of workplace, etc. Assume, initially that the demand for safety and the price of its provision are static. In the absence of information costs, there would be a prevailing level of safety in new construction. Without some mechanism for assuring quality of the structure over a prolonged period, greater uncertainty would characterize housing choices. Households' mobility would tend to be reduced and they would to a greater extent live in housing which they consider unsatisfactory. They would be willing to pay (as a lump sum for moving, and other charges associated with the transaction) to obtain alternative housing (at a higher or lower carrying costs); but the costs associated with information on safety would prevent such adjustment except where the features of the housing occupied are very much different from those of the housing desired. Prevailing building codes do not affect directly the entire population of households, but only those who occupy newly constructed or renovated housing. All households have an interest in safety levels of housing generally, not only their own, because they are all potential occupants of other housing. Alternatively, one might think of a situation in which some original purchaser, in the absence of building codes, provided very low levels of safety in his dwelling, partly through the installation of material with short expected lifetime under normal use.

Subsequent occupants would require some additional payment for the installation or replacement of safety features to bring the dwelling's safety back to the original level or above. The original and each subsequent occupant would invest in safety features up to a point where the extra utility derived from additional safety during his own tenure and the pecuniary return on such investment due to a higher re-sale price were just equal to returns from other expenditures. Each household knows that the subsequent household will have only imperfect information about safety in the dwelling. Acting rationally, each occupant household invests less on safety features than it would if information were costless. This underinvestment presents a particular problem in the case of the original occupant, since the marginal costs of safety are much lower in original construction than in maintenance and renovation (a point to which we shall return in the next section). Building codes are intended, by setting standards sufficiently high, to assure the capture of these economies in original construction and to inhibit the incentive to reducing safety levels over the life of the structure. This source of externalities has an interesting distributional effect in the case where the demand for safety is rising. Expenditures on safety associated with dwelling characteristics appear to be increasing gradually over time, at least if the detail and complexity of building

codes are a guide.* This trend is associated with rising incomes. First, consumers are willing to spend more to protect life and limb. Second, increased incomes result in higher quality housing and greater value at risk. Third, residential activity has become more complex, and the dwelling has had to adapt new demands on its physical fabric and structure resulting from widespread ownership of the automobile, a variety of "gadgets", etc. As in the case of static demand per household for safety, all households benefit from high standards in new construction. With rising standards, there is an additional cost to purchasers of new housing, who must conform with higher standards, not borne by residents of the standing stock. There is a transfer of income from the former to the latter, insofar as the additional expenditures are not adequately reflected in capital values, i.e., do not correspond with a normal return, adjusted for the use value of the safety features.

iii. Altruism

A third type of externality is the purely altruistic one. Society as a whole desires that each of its members not be subject to unreasonable risk to health, safety and property. While it is recognized that some individuals are willing to accept high levels of risk, the loss or injury, even of such

* While expenditures resulting from code provisions have likely risen over time, the efficiency with which safety levels are attained has probably also risen, due in part to a continuing attempt since the 1950's, to reduce excessive restrictions in line with research findings.

individuals and their property inflicts "psychic costs" on the remainder of society.

C. Effects via the Housing Market

i. Supply Side

Our schematic representation of the demand and supply of building safety assumes a stable supply curve. This assumption implies a declining marginal efficiency schedule. The "cheapest" features - those which yield the greatest addition to safety per dollar of cost - are introduced first, with subsequent additions being increasingly costly relative to their contribution to safety. Much of the continuing research and revision of building codes under the present system is devoted to the objective of increasing efficiency, by substitution of materials, altering minimum dimensions, etc. The problems ensuing from information costs are not a demand-side phenomenon alone. Producers may unwittingly include features with relatively high cost-safety ratios which produce relatively low marginal dollar returns, in an attempt to reduce their exposure to legal action arising from failure to provide protection from death, injury or structural failure in use. While the cost of including the additional feature may be known with great precision by the builder, its effect on safety likely is not. Like the consumer, the producer's choice of safety-related features depends in part upon his

attitude toward risk. Other things equal, the more risk-averse the builder, the greater will be his tendency to install high-cost, low safety-enhancing features, in addition to those of relatively great efficiency. In the formulation of building codes, it is attempted to arrive at an efficient configuration of safety features, i.e., for a presumed level of safety, to achieve minimum construction costs. Efficiency in a broader social context depends upon whether the building code process raises the marginal efficiency schedule (moves the supply curve to the right, or "increases supply") of safety for a lesser expenditure of resources than would obtain under some alternative system. Such an alternative system for increasing efficiency might include, e.g., research and development financed by the builders themselves*.

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* It might be argued that, since we are dealing with a good, the quantity of which is only poorly and indirectly measureable by the producer, the construction of a conventional supply curve is called into question. It must be pointed out, however, that the market transaction pertains to the transfer of rights to some objective commodity or service which yields utility to the consumer. Competing producers may offer qualitative variations among which consumers choose on the basis of relative prices. The marginal efficiency of quality features, is determined by consumer acceptance, which affects marginal cost, hence the "expansion path" of incremental characteristics. This model holds regardless of the degree of uncertainty on the demand side.

At least insofar as costs arising from uncertainty are concerned, the building code system has the effect of transferring costs from builders to society generally. First, the costs of obtaining information on safety-features are borne to a considerable extent by public bodies. Second, insofar as conformance to building codes represents prima facie evidence of sound building practice, the builder is to some extent protected from litigation.

Thus far, our discussion has been presented in terms of individual choice - individual consumers and producers. For the purpose of examining the allocative efficiency of building codes it is necessary to consider the results of this microeconomic behaviour in altering safety in residences as a whole, as well as the associated costs. In the aggregate, the supply of "safety" in housing through the provision of specific structural features is associated only with the flow of new housing services, including upgrading of the existing stock through renovations. In addition, devices for increasing safety without structural alteration, as through the installation of smoke detectors would make possible a substantial increase in safety in the standing stock. Such devices may play an increasing role in building

safety in future, especially if the potential of "wired city" technology is realized - experiments in communicating fire alarm signals to a central point are already underway. There developments are largely in the future of building safety production, however. The emphasis upon building safety regulation in the existing stock is still upon housing codes the enforcement of which, in practice, is probably concerned mainly with preventing gross violations of occupancy provisions at the low end of the quality scale. Thus, the effect of building codes in altering the overall level of safety in the housing stock is an effect almost entirely at the margin, in the form of new construction of substantial (i.e., sufficient to require a building permit) renovation.

ii. Substition possibilities

Under the discussion of neighbourhood effects, we touched upon the possibility of substitution between safety-related and other features, which we grouped under the term "amenity". By preventing the construction of dwellings with very low safety

levels, building codes allow the property owner to reduce his costs of providing a specific level of safety (price of safety), because of the decreased risks of fire spreading from neighbouring structures. In addition, the reduced cost of obtaining information about the relation of building features to safety corresponds with greater efficiency in producing safety . On the other hand, the net effect of building codes may be to increase total costs of safety features above the level which the owner would choose, even in the presence of externalities, and the knowledge generated by research and development associated with codes. In what follows, we shall assume this to be the case, to make the reasoning less cumbersome. It is possible, on the other hand, that the minimum requirements imposed by building codes do not represent binding constraints, i.e., the consumer would purchase at least as much of safety-related features in the absence of codes; however, there is good reason to think otherwise, as will be discussed in a later chapter. Should free-choice levels of safety features be, in general, higher than those imposed by codes, then reasoning converse to that presented here would hold.

iii. Stock-flow relationships

At any point in time, the relative price of a standing and a newly-constructed unit or newly-renovated housing unit (we shall henceforth refer to both as new housing) reflect the market's relative valuation of the features embodied in each, including features associated with safety. To the extent that the safety features imposed by building codes result in a distortion of the bundle of characteristics of the housing unit compared with what would be freely chosen by consumers, the cost of producing housing services is increased, without a commensurate rise in consumers' willingness to pay*. Investment in, and the production of, new housing is curtailed and the movement of the overall level of safety toward the standards implied in building codes is accordingly slower. The more the resultant

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*Assume, as an extreme case, that the consumer derives no utility from safety features and would be unwilling to pay for them with free choice. For a unit of given non-safety-related features, additional features imposed by building codes are, say, equal to the original cost. The price of housing services (safety not being perceived as a service) is doubled. Assuming some elasticity of demand, the consumer would purchase a unit of lower quality, i.e. yielding less in the way of housing services.

dwelling characteristics diverge from the set which would have been chosen by consumers without non-budget constraint, the slower will the safety level of the overall housing stock be in adapting to the standards of building codes. Older housing, with qualitative differences from new construction - partly because it was constructed under a different, and usually less stringent set of building requirements - may be maintained at a higher level and its durability extended. This higher level of investment in the standing stock is associated with higher market values reflecting a greater proportion of amenity features than they would have displayed if originally constructed under codes now prevailing. At the low end of the quality spectrum of the housing stock, in particular, units will be maintained longer, rather than being converted by voluntary action of the owner or being allowed to deteriorate to the extent that condemnation and demolition occur. From the point of view of providing shelter to low-income households, this result may be a desirable one; but, aside from the growth of slums and blight which may in part be associated with the sheer age of structures in a neighborhood (obsolescence), features inconsistent with current social standards of safety (as represented by building codes) will be more common in such housing at any point in time.

Durability of the structures being added to the housing stock also influences the rate at which safety levels in the stock as a whole will change. In a period of generally rising safety standards, such as the one we have passed through, increased durability due to codes would have the effect of retarding the spread of still higher standards, and conversely if they reduce durability. The above indicates that the durability of housing depends, not on the physical characteristics of the original structure alone, but also upon the behaviour of owners in maintaining and renovating their properties. Building codes are popularly believed to result in more durable structures. To the extent that they provide greater resistance to the destructive forces of Man and Nature, this is so. If they yield housing which is less productive of housing services desired by consumers per dollar of maintenance cost, however, they may actually reduce durability by reducing such maintenance. Probably relatively few dwellings disappear as the result of fires and natural disasters, compared with the number voluntarily converted, abandoned or demolished.* With respect to the effects of building codes on durability via their impacts on costs of maintenance and renovation, they may increase durability, by requiring in the initial construction physical features which facilitate subsequent

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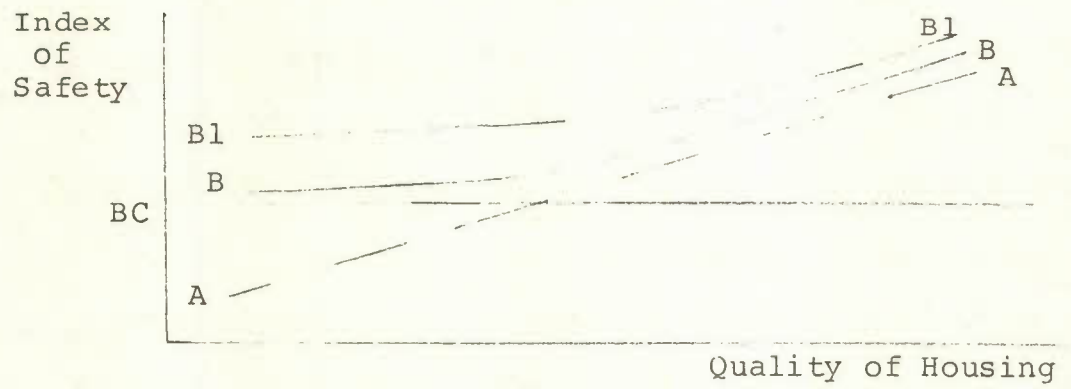
* Hard evidence on demolition rates is almost non-existent.

maintenance and renovation - better materials and more solid structural elements. The consumer may be willing to invest an additional amount on code-type features in the original structure beyond what is required, in anticipation of reduced costs of maintenance over the life of the structure. On the other hand, substantial renovation of structures, even if they were built to specifications corresponding to codes prevailing at the time of such renovation, may be very costly. The methods and materials which may be employed are in any event severly limited by the existing configuration of the structure. Code limitations are therefore likely to have an especially severe effect upon unit costs, tending to inhibit at least some types of renovation*.

iv. Distributional effects

The distributional effects of building codes via the housing market can be elucidated by reference to the following diagram.



* It is perhaps revealing that one of the municipal building department officials whom we interviewed said that, while builders generally submitted plans which were above the code's minimum requirements the two instances where they tended to "cut corners" to an extent which transgressed such requirements were in socially assisted housing, where revenues are limited, and in renovation.

Assume, initially,that there exists no re-sale market for housing, i.e., all households purchase housing services in new structures. The dashed line A A indicates the level of safety which would be chosen, at each quality (and corresponding income) level in the absence of codes. It is assumed that this level would rise with increasing income and housing quality. First, some safety features, at least, are directly associated with amenity features, (means of egress, fenestration, etc.) and the latter are "superior goods", i.e., expenditures on them increase with income. Second, safety is itself a superior good. With increasing income, the household is willing to pay more for its own safety, as well as the protection of its more valuable housing unit.

Assume that building codes are introduced which require some level of safety BC , which is invariant over time. Depending upon the stringency of building code requirements (the height of the horizontal line) households generally will occupy housing which is at a higher level of safety than they would choose in the absence of codes, as indicated by the curve B B. The lower the quality of housing, and the corresponding income level of its inhabitants, the greater the excess of the mandatory over the voluntary safety level.

For the higher-quality portion of the spectrum, households are free to choose their level of safety, which exceeds that of the code. They might in fact choose a higher level than in a no-code world, if their perception of the marginal-efficiency schedule of safety features differs from that implied by the code, i.e., they would be forced to comply with code regulations at a minimum, but would add other features voluntarily.

In reality, the re-sale market is very important in allocating housing services. New housing is added in the middle and upper portions of the quality spectrum. Such new housing is occupied by middle- and upper-income households. Housing "filters" to lower-income households as it declines in quality and/or becomes obsolescent (because of changing fashion, neighbourhood quality or changing physical requirements due, e.g., to increased automobile ownership and the need for garaging, etc.). One reason why new housing is not competitive in price with old, filtered housing is the component of construction cost stemming from codes.* While the costs of safety features may be assumed to be shifted entirely to the buyer of new housing, they would be increasingly discounted in the re-sale market as the housing "filtered" to successively lower-income groups, as implied by the upward-sloping line A A. Because of the depreciation of that portion of the dwelling's value attributable to safety features, rational behaviour on the part of residential

* Some new housing enters the lower end of the spectrum via, social housing. It is still a minor share of housing consumed by low-income households, however. In the case of such housing, additional costs attributable to building codes have a more direct linkage to consumer expenditures on shelter.

property owners is to under-maintain the property. Such under-maintenance probably has a differentially greater effect on amenity than on safety. The latter is to a large extent "locked in" to the basic structure of the building and is not significantly affected by the level of maintenance. The result is that the process of filtering may further distort the characteristics of the housing available to lower-income households toward greater safety and less amenity, represented in the diagram by the curve B1 B1. At least three influences act in the opposite direction, however. First, during the process of filtering, dwelling space is likely to be used more intensively - families double-up, large dwellings become rooming houses, etc. Such changes lower the level of safety of the dwelling. The resulting level of safety may even fall below that implied by code provisions applicable to new buildings (B1 B1 lower than BC at the low-quality end). Second, the safety level may deteriorate over time as the result of technological change. The electrical system, for instance, may be burdened with ever increasing loads from a variety of appliances not widespread at the time of construction. Insofar as such technological change tends to be introduced in the medium- and high-quality portion of the stock, which is constructed or adapted to it, this problem is mitigated.

On the other hand, rising income and population exacerbates the problem by placing pressures on the housing stock so that it cannot adapt to the change rapidly enough to maintain the safety norm. The line A A shifts upward over time, and may exceed B1 B1, even in the low-quality portion of the stock, reflecting the imbalance of demand for safety and the capacity of the stock to fulfill it. Both these effects, therefore, would argue that "excessive" code requirements, while they may impose net allocative costs because of constricted supply etc., may be justified on distributional grounds. A third possible effect is that, by the choice of a dwelling type, the consumer may be selecting a price of safety. Suppose a given level of safety requires less resources in a dwelling within a multi-unit structure than within a single-family house. The price of safety is not equalized among households because safety is inextricable from other services yielded by the housing. Consequently, the level of safety chosen by the typical low-income household may not be significantly different from that of the high-income household. Conversely, a higher relative price for safety in multi-unit structures could yield a large disparity in protection between high- and low-income households, even in the long-run.

D. Summary

Whether households pay more for housing as the result of building codes, and whether they realize higher levels of safety depends upon several factors. The reduced costs of obtaining information about the relation of

building features to safety corresponds with greater efficiency in producing "safety". In the absence of uncertainty, we might therefore expect the household to spend more on such features; however, safety implies risk, and the expenditures which the consumer might make on safety may be more or less than what he actually pays for such features, depending upon his attitude toward risk.

The imposition of minimum standards, implying additional costs of safety features, insofar as it causes a reduction in expenditures on other housing features leads to lesser satisfaction with the services which the dwelling provides. This may result in a shift in housing demand which, through altering the choice of new housing characteristics and maintenance policies actually lessens safety. The speed with which safety levels implied by building codes come to predominate in the standing stock, for given rates of population, income and price change, depends on the one hand upon the improvement in resource allocation attributable to the reduction of certain types of external diseconomies, and, on the other hand, the costs represented by the distortion of the housing bundle compared with what would have been chosen by the consumer in the absence of codes.

Chapter 3 - The Construction Industry

A. Safety in Construction

The existence of building codes results from the unwillingness of society to accept the risk of unsafe housing. This statement implies that builders have an incentive to build housing, the safety of which is significantly below what individuals with the ability to assess accurately such safety would be willing to purchase. Against the presumed reduction in risk and higher amenity value of housing must be balanced, among other considerations, the private costs of production of the additional, or higher quality housing features. The presumption that builders, left to their own devices, would provide unsafe housing rests upon two features of the housing unit. First, many of its properties related to safety are not apparent to the untrained eye. In a finished unit, even the expert would not be able to make such a judgement on some features by non-destructive inspection. Secondly, the housing unit is long-lived. Many faults might only become apparent long after the transaction between builder and original buyer, or indeed after subsequent transactions for the aging unit. Further, purchasers of housing enter into transactions only infrequently, and only rarely with the same builder more than once. The element of "brand loyalty"

is lacking in this particular market. As in the case of risk-loving households in relation to neighborhood externalities, individual builders, in the absence of codes might be "free riders" - producing structures with lower safety levels than others in the industry. In a competitive industry, the lower costs obtainable from this strategy would reduce safety standards generally. Against these factors, there is at work, in the absence of building codes, only the incentive for builders to maintain a level of goodwill in the community. By achieving a reputation for building sound housing, both in terms of workmanship and safety, the residential construction firm increases its chances for marketing its products in future. This incentive is much weaker, however, than in markets for goods where there are opportunities for "repeat sales", as with appliances, automobiles, furnishings and non-durables.

The introduction of building codes, in addition to enforcing a minimum standard of construction, may not be neutral in its effects upon firm and industry productivity. The constraints imposed by building codes may act to increase the cost of a housing unit of specified physical characteristics. The channels by which this effect is realized

will be discussed, in this chapter, under three headings - market structure, stability and product mix. It should be borne in mind that the effects of building codes depend importantly upon whether a uniform code covering a number of housing markets - as in a system of provincial codes - or a variety of significantly different municipal codes is in force. Some of the arguments to be advanced pertain to the latter situation, which is now disappearing in Canada. As such, they are relevant for the consideration of benefits and costs of instituting province-wide codes.

B. Market Structure

i. General

The characteristics of the structure of the construction industry of relevance for a consideration of the impacts of building codes have been cited in a recent U.S. study by Field and Rivkin (5, pp. 11-15):

> Due to localism of consumer demand and of building regulations, the builder must develop an intimate understanding of what is selling in each community...Even if a builder has accurate market information, he is usually unable to counter the prevailing trend...Boom or bust is a reality for all builders of local housing; it undermines the sense of stability so vital to a large-scale business...

> The builder... has used subcontracting to minimize his financial investment. Subcontracting is a rational approach to this business. All concerned share in the risks of the construction process, and each participant makes his own capital investment. It also facilitates the movement of builders from one market to the next. When a builder switches markets, he need not train a new staff and crew, for a network of participants exists within each market...Transformation of conventional building practices has been dramatic over the decades...The builder is increasingly becoming a coordinator of subassemblies rather than a carpenter with hammer and nail constructing the house from the ground up.

The existence of large numbers of small builders and the evolution of vertical specialization may, as suggested in the above passage, be attributable partly to the existence of localized building codes*. Information about differences in code provisions and enforcement among jurisdictions and the effects of such differences upon optional product characteristics and production methods represent potential costs to the builder. Initially, on entering a new jurisdiction, he must obtain information to enable him to make the appropriate production decisions. Once

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* In Canada, of 14,234 establishments engaged in residential general building contracting in 1975, 11,965 (84%) had a value-put-in-place of less than $250,000. Only 494 establishments had values in excess of $1,000,000. (2).

established, he is obliged to internalize differences in specifications of the housing which he produces at any given time. Potential economies from large-scale production and industrialized, off-site fabrication are mitigated. Field and Rivkin point out that recourse to large numbers of local subcontractors is a response to these externally-imposed conditions. The existence of these large numbers of small-scale specialists may be assumed to promote efficiency, in accordance with the traditional competitive model. Such a structure might be expected to arise in the absence of local codes, however, if it is truly more efficient, and if other market imperfections did not prevent it. In particular, we might question whether the existence of uniform codes or the absence of codes might make a significant contribution to the capture of economies of scale and of product specialization, with or without greater off-site production. Significant opportunities for scale economies, if they exist, might be expected to lead to monopolies in the industry or in individual markets and the squeezing out of competition and its associated benefits. The classical conditions for natural monopoly are the existence of high fixed costs and undifferentiated products. Neither of these conditions characterizes residential construction in individual market areas. The entry of large numbers

of small builders in times of surging demand is evidence of the low fixed costs associated with homebuilding. Perhaps the largest single element of fixed cost is in holding land for development. A great deal of attention has been paid to monopoly elements in this phase of housing production. Vertical specialization tends to limit the effects of such monopoly, however. Large-scale developers sell off portions of their holdings, even in increments as small as single parcels to individual builders, in order to mitigate risk and to maintain cash-flow. In an individual housing market area, therefore, monopoly gains are likely to be limited to the land portion of housing, which in turn, may represent 15 - 30 percent of the total production cost. With respect to the structure itself - the component for which building codes are directly relevent - significant cost savings have been realized in recent years through off-site fabrication of components. Insofar as scale economies have been realized, they have been associated with plants devoted to "production to stock" as well as customized but large-scale assembly of such components. The result, as indicated in the quotation above, is that the builder is increasingly becoming a coordinator, rather than a contractor. His functions,particularly for non-high-rise housing are tending toward land assembly, provision of services,

excavation and construction of the foundation, assembly of components, finishing the assembled structure, arranging financing and marketing. Frequently some of these are also sub-contracted.

ii. Off-site construction

Early attempts at factory-produced housing were in the form of complete units, assembled for shipment in sections. Largely because of the high costs of transporting these sections, this type of manufactured housing is competitive only within a limited geographic area. Consequently, production has been confined to plants in the larger metropolitan areas and serving primarily the local market (67). The sizes of these markets have apparently been insufficient to allow plants to take full advantage of scale economics. Significant growth has taken place, and will probably continue in the factory production of housing components for which both transportation costs and minimum efficient plant size are smaller (68). These components, ranging from kitchen cabinets to "open panel systems" represent a process which is intermediate, in terms of the mix between on-site and off-site production, between the traditional method and the modular or sectional method. In low-rise housing, generally corresponding to NBC Part 9, market share for prefabricated roof trusses, windows, kitchen cabinets is 85 - 95%, wall panels 10 - 30% and foundations, exterior finish, heating and plumbing systems 5 - 20% (70, p. 91).

The relative extent to which building codes and uniformity of codes , on the one hand, and transportation costs on the other hand influence the degree of market penetration of manufactured housing, the mix between off-site and on-site production and the resultant costs of production is difficult to assess without a detailed quantitative examination. Given that considerable uniformity in code provisions as a result of the NBC has existed for 2 - 3 decades, and given the great dispersion over space of Canadian housing markets, transport costs are probably much the more important factor. In the United States, the experience with manufactured housing is very similar. (5, p. 22). Even with much larger concentrations of population, it has apparently been impossible for methods utilizing predominantly off-site production to achieve large market shares. Since much larger populations can be reached at distances corresponding with a particular level of transportation costs, it might be reasoned that reduced costs from increased plant size will be more than offset by increased transportation costs, even in regions as densely-populated as those of the U.S. On the other hand, variance among municipalities in building code regulations has probably been greater in the U.S. than in Canada. A set of uniform code provisions, super-imposed upon the denser U.S. markets might have greater impact there than in Canada.

Another factor to be considered is product differentiation. Such differentiation, by creating a plethora of sub-markets among and even within individual housing markets may lead to specialization by individual producers. No single producer is able to meet efficiently at any one time consumer demand for variations in a wealth of structure types, dwelling layouts, finishes, etc.. Minimum efficient firm size may correspond, therefore, with the production of only a few units annually. The experience of the firm which was most successfully able to market a large volume of standardized housing, produced largely on-site, in the U.S., is revealing (44, p.69):

> We believe that the house of greatest ultimate value is one that is built over and over and over again, tens and hundreds and thousands of times... We reluctantly modified our operation only because a changing marketplace dictated a change as a requisite for economic survival.
> Instead of building 5000 identical houses at a single site in one year, we now build 5000 houses in 150 varieties at 18 sites during the same time, houses whose designs are dictated primarily by marketing, not production disciplines. Obviously, we have not been able to keep the same production efficiency in our present circumstances, as we enjoyed many years ago.

In periods of severe excess demand, consumers are more likely to forego style and other differences in favour of earlier purchase of a standard housing unit. When demand and supply are more nearly in balance, taste

differences again become significant in the market. This conclusion might also explain why industrialized housing has had its greatest success in post-war Europe.

C. Stability

Insofar as building codes contribute to lesser concentration and to decentralized, predominantly on-site production, they aggravate demand - supply imbalance. The entry of large numbers of small builders during periods of rising demand leads eventually to an excess inventory of completed and in-progress units which cannot be readily sold. High carrying costs and defaults on financing obligations force many builders out of the market, with some resources diverted to non-residential construction. With the working off of this overhang, there is a delay in the return of builders to the market until after excess demand reappears. If large firms, operating in a number of housing markets, were more prominent in the residential construction industry, supply-side instability, it might be argued, would be reduced. Such firms would, partly through vertical integration, have more reliable input markets (land, labour, materials, financing) and would also be able to shift production among markets (locational and product type) so

as to reduce large inventory buildups. The building code system, depending upon how it is structured, may favour small enterprises by reducing fixed costs. Where there is substantial variation in code provisions among municipalities, the medium- or large-scale builder faces substantial learning costs*. Of perhaps greater importance is the difficulty he faces of capitalizing variations into the price of land. Land banks are desirably assembled well in advance of development on the urban fringe; but municipalities in these areas are the most likely to increase the stringency of regulations as development proceeds. In addition, there may be consumer resistance to differences in prices of apparently (because safety features are invisible) identical housing units in equally-desirable locations. The move toward more uniformity in codes therefore favours the larger builders, who are also spared the additional costs of unsuccessful campaigns with a variety of jurisdictions for the retention or reduction of existing standards. Even in a system of uniform codes, however, the existence of the centralized, publicly-supported research and development facilities in the DBR and the information dissemination functions of DBR, CSA, CMHC and other bodies constitutes

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* This problem was circumvented by the U.S. builder, Levitt, cited above, by building large tracts of housing in individual municipalities - so-called "Levittowns".

a reduction in fixed costs. This reduction favours smaller builders who would otherwise lag behind larger firms in the adoption of new methods and materials. Furthermore, variations in code enforcement among jurisdictions tend to favour smaller firms, for the same reasons as variations in formal code provisions. Learning the particular emphases of individual building inspectors and establishment of goodwill between builder and inspector militates against centralization of managerial activities beyond the level of the individual housing market. These effects may be somewhat counteracted, however, by the practice of local jurisdictions of requiring, particularly for fire prevention purpose, the testing at the builder's expense of innovative structural and finishing arrangements. The costs of such testing can be spread over a larger number of units by the larger builder; however, they may deter the builder from developing an efficient solution to a problem posed in a particular building.

We have discussed, in the previous section, the growing role of off-site fabrication of building components. The contention that variation in building codes has played a major role in inhibiting off-site production e.g., in (5) appears to be unwarranted for the Canadian situation. Transport costs and differentiated demand are probably much more significant. These same factors are present in

the determination of optimal size of plant and enterprise. As in the case of off-site construction, the influence of building codes would appear to be of secondary significance compared with these factors. Several developments have combined to decrease instability in residential construction since the late 1960's. (69, Ch. 6). These include the role of CMHC as lender of last resort on social housing and the freeing of the NHA mortgage interest rate to fluctuate in response to market conditions. Much of the improved stability stems from changes in the construction industry itself, however. The increased share of off-site manufacture in the construction process and the existence of specialized plants able to ship individual components competitively to distant destinations has created and spread markets which were previously internalized to firms and isolated by urban area. The transition to essentially a national code with some variation by province will undoubtedly facilitate this trend.

There remains the further possibility for changes in the NBC and the closely-related provincial codes which would favour more efficient methods and a greater degree of assembly off-site.

D. Technological Change and Productivity.

i. Diffusion of innovation

There are two principal ways in which building codes have influenced technological change and productivity in residential construction. First, it has been widely recognized that the pace of change in utilization of new materials and processes - technology transfer - has been attenuated by the existence of variations among jurisdictions in code provisions (69, p. 33)(70, p. 86) (5, pp.72, 79) (24) (6, pp. 90-91) (71). The industry is comprised of a large number of small firms. The entrepreneur must deal with large numbers of factor and material input suppliers, as well as having to gauge, on the marketing side, consumer acceptance of a host of features of the final product. Consequently, the information exchange possibilities for the industry are vast(70, pp. 79-89), whereas the competitive level of resources which an individual builder may devote to absorbing new information are very limited. In addition, building at the scale of most of these firms' operations is a high-risk enterprise. Contractors are therefore very hesitant to adopt new technology. Variations in building codes among jurisdictions have complicated the technology transfer process. Different rules in different localities mean that a specific innovation

may be irrelevant in some places, unless builders or their suppliers are able to convince the local authorities to make the appropriate code changes*. Even with a uniform code system, there may be a residual problem of acceptance by local inspectors, who will continue to exercise some measure of judgement. In this respect, as well as in connection with enhancing the flow of information to builders, a number of federal and provincial agencies will continue to supplement the activities of private suppliers. Indeed, they may be expected to become relatively more important as the relevant changes in codes to accomodate technological change become more centralized. These include most prominently DBR, CMHC, the Canada Employment and Immigration Commission at the federal level and the provincial industry and housing departments. In addition, the agencies charged with the administration of the provincial codes are becoming focal points for such information activities in their respective jurisdictions.

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* The long period of introduction of plastic pipe for plumbing is frequently cited in this connection for the U.S. (24) (5) (6) but there appears to be little similar evidence in Canada. It appears that the innovation has been introduced initially in single-family housing, then successively, in line with subsequent changes to building codes, to two-family and multi-family housing. To this date, it is not included in the NBC for large apartment buildings. In the fifteen years since its introduction, it has captured about 90% of the market for drain, vent and waste plumbing application, according to a DBR staff member.

ii. Standards

A second way in which building codes influence technological change and productivity is by setting standards to which builders must adhere. Assuming uniform standards - a situation which is now becoming more general - and effective competition in all markets, this influence works in two opposing directions. On the one hand, corresponding with any particular set of safety-related requirements for individual components of the structure there exists a set of production techniques which is most efficient in meeting them. By stating explicitly what is allowed, the code becomes a source of information which reduces the number of available technological alternatives and hence the costs of search and experimentation. On the other hand, the abundance of minimum requirements and specification of particular methods and materials inhibits the development of housing - possibly of radically different design - which may contravene individual provisions but yield an overall level of safety which is consistent with the intent of the code. Building codes are, by and large, written in a piecemeal fashion, reflecting the wealth of individual components of the dwelling and of opportunities for accidental injury and death associated with residential activities. Consequently, they reflect a "weakest link" view of safety provision.

Two developments in code formulation work in the direction of liberalizing this otherwise very restrictive approach. First, some code specifications are contingent upon other features not being present in the structure - an either/or formulation. Second, specifications are being replaced by performance standards. Most simply stated, the latter will involve output criteria, the former involve input criteria. Both of these developments are as yet very limited in application within the NBC. Referring to performance standards, one authority states the problem of making their use more widespread as follows (72, p. 4): "... the ability to design for any desired result depends entirely on the ability to predict the result in advance. Design without such ability to predict involves experiment or trial-by-use." There is a problem in specifying and conducting tests for conformance with performance standards for individual items such as the deflection of beams or trusses. The problem would be greatly compounded if whole sub-systems, or indeed the entire structure were governed by a single performance criterion. The same authority characterizes the latter as absurd. Yet the objective of the building code is or should be not the installation of a set of building elements, but the provision of housing which provides some level of safety most efficiently. That there has not been developed a method for comparing dwellings on one or a set of indices

of safety, as discussed in Chapter 2, may reflect the state of building science. The state of building science, however, itself reflects the preoccupation with parts rather than the whole. The orientation to laboratory testing leads to the prospect of costs too high to justify potential benefits, especially with differentiated products. Yet there exists, for the purpose of comparing the performance of conventionally constructed dwellings a vast number of potential observations, in the form of the existing stock. This possibility has been noted by the Construction Industry Development Council (70, p.p. 88-89). Furthermore, new designs might be feasible which, in combination with standardization and large-scale production, reduce construction costs sufficiently to overcome the effects of demand for differentiation. Such designs are unlikely to be developed if the additional cost of wholesale changes in building codes must also be faced.

Chapter 4 - Collective Action and Optimal Jurisdiction

A. Introduction

The justification for public intervention in residential building, as presented in the preceding chapters, revolved around the impediments to a free and informed choice by individuals of housing, the safety characteristics of which accord with a social optimum. In the present chapter, we shall be concerned with the implications of alternative arrangements for public intervention for the aggregation of individual preferences, with the manner in which decisions are actually made, and with problems of developing methods by which some or all of the ends of building regulation may be accomplished through private means.

B. Aggregation of Preferences and Efficiency in Public Goods Delivery

i. Rationale for centralization

The National Building Code, and the process by which it is formulated and revised have been viewed as something of a model for developing the substantive elements of a regulatory area. The Chairman of the Canadian Government Specifications Board has described it as follows (30):

> I believe our national building code, produced by the consensus process by an advisory committee of National Research Council is an excellent example of the cooperative development of a national code which can be used for regulatory purposes by different levels of government where necessary. Because it has been developed on a national basis it

> reduces conflicts between the needs of different areas of the country and ensures that building products meeting code requirements can be used in all regions of the country.

The process of formulation and implementation of building codes, as with most other regulatory processes may be seen as a method for aggregating the preferences of the individuals comprising society to arrive at a common level of output of a particular good - in this instance the reduction of risk to people and property. By contrast, markets are mechanisms for aggregating preferences so as to establish a common level of price. In a confederation such as Canada, variation, if any, in the weightings on individual sub-group preferences runs along regional lines, as represented by provincial boundaries.

The structure and procedures for formulation of the National Building Code, alluded to by the CGSB Chairman are indeed elaborate, and indicate a sincere effort to achieve consensus among the provinces in light of the best available technical information gathered and generated by resident scientists and engineers and interpreted by the experts from industry and government who constitute the various sub-committees

of ACNBC. This elaborateness seems appropriate. First, the resource allocation decisions which flow from the regulations are large. Second, the regulations are highly technical, involving requirements for a variety of expert knowledge. Third, there is a low practical upper limit on the confidence (in a statistical sense) with which the effect of a specific regulation upon the safety objective of regulation can be predicted. Consequently, recourse is made to instrumental measures such as can be developed in a laboratory. The set of judgements relating (explicitly or implicitly) these measures to safety are sufficiently hazardous and sufficiently critical to the whole process of building regulation that no single individual is deemed competent to make them. (In terms of government behaviour, the system may be said to be one in which political risk is diffused, analogous to private insurance). At the provincial level, similar structures exist, primarily for deciding which features of the NBC should be altered, supplemented or deleted.

ii. Sources of bias

In considering how accurately this regulatory structure represents society's preferences, several factors should be noted, some of which are present in a range of regulatory situations - not only building regulations. Some of the

problems of making regulated outcomes correspond with the objectives for which the regulation was instituted are related to "market failure" due to some of the same causes which originally prevented the formation of private markets to deal with the problems.

Costs of information are sufficiently great that only a single, centralized activity could perform efficiently the amalgamation of research and field experience into the building process. By the same token, the political representatives feel unequipped to make decisions on the content of codes, delegating instead this function to experts. If building safety were left to private markets, consumers would choose safety features (however poor the quality of information) on the basis of price, while producers would offer such features at prices reflecting marginal costs. In removing direct responsibility for the provision of safety from the parties to the housing transaction, the requirement of minimum standards may lead to biases.

The authority vested in a regulatory jurisdiction may be employed to give consistently greater weight to the interests of either producers or consumers. Many investigators of

regulatory situations have pointed out the "anti-consumer, pro-producer bias" (58, p. 255) of governmental mechanisms, even those ostensibly established with the primary objective of protecting consumer interests. Regulatory agencies have frequently been characterized as having been "captured" by the industries which they are charged with regulating. On the other hand, Trebilcock et al. (50, pp. 40-41) have argued that market distortions stemming from regulation may run against producer interests. In the case of regulation through building codes, both a priori reasoning and inspection of the institutional structure tend to the conclusion that producers are favoured. In terms of resource allocation, the result is likely to be a greater use of resources for safety relative to amenity features than would be achieved by unfettered markets, and possibly also a greater expenditure of resources for safety in absolute terms. The reasoning on which the building regulation is based rests upon a series of contingent assumptions which have the cumulative effect both of removing decisions from consumers and of blocking the introduction of alternative systems which may more accurately represent consumer interests. The difficulty of evaluating the effects of construction practices and materials on safety through any type of expert evaluations of the performance of housing with specific characteristics,

e.g., by probabilistic analysis, leads to reliance upon tests to establish indirect measures of safety (flame retardation of components, etc.). The high costs of conducting such tests or otherwise gathering information pertaining to the safety and durability of components argues for recourse to centralized bodies for generating such information. The technical nature of this type of information, as well as the impacts upon building practices and costs which its implementation entails introduces the requirement for experts capable of organizing the information-generating process and interpreting results. Incorporation of the information developed into building practice is assumed, because of the "free rider" problem to be an appropriate area for public control. Discretionary use of safety information by producers and consumers could lead to fraud, lack of confidence and costs of verification of production by honest builders and other sellers, and inflicting loss of life and property on neighbours and tenants, etc. Finally, the coupling of information and implementation functions in a single system (even though the link is nominally an "advisory" one as between the national and provincial codes) has an apparent efficiency rationale. A single system avoids duplication of the costs of producing regulations, and a single enforcement system may achieve economies in direct inputs (more full-time workloads for inspectors, etc.) and in training, etc.

This rationale for the creation of a system of public regulation of building is based primarily on supply - side considerations. Problems associated with information costs and externalities render demand forces ineffective in changing the system or the amount of safety to reflect consumer preferences. It is unlikely that individual consumers will combine to create political pressure for less intervention. Resource allocation and distribution effects arising from such sources as inhibition of technical change are not readily apparent to consumers. Similarly, the reliance on "experts" to regulate by means of minimum standards is unlikely to be questioned, first, when consumers are not even aware of the direct costs of safety features and, second, because accidents, when they occur, are rarely attributable solely to structural features, i.e., "human failing" is usually blamed. Building safety features are not of a type the use of which is discretionary on the part of the consumer (like, e.g. seatbelts). Features mandated by building codes are, by definition, built into the housing at the time of construction or renovation. Some of the effects in enhancing safety may be mitigated by poor occupancy practices. In general, however, the capacity of the housing to reduce accidents and fire is variable only within a narrow range. Consumers consequently are only poorly aware of structural or non-

structural alternatives for providing safety or of possibilities for altering the level of safety.

iii. Induced distortions in production

The critical mechanism which is lacking in the replacement of private markets for the allocation of resources to building safety by the building code system is the assumption of risk by producers as a quid pro quo for pecuniary rewards to be obtained by meeting quantitative and qualitative levels and changes in consumer preferences efficiently. Producers will avoid such risks as they will avoid competition itself, if they can do so while still obtaining a normal entrepreneurial return. In a competitive situation, firms will employ a variety of devices to increase their profits or revenues. More efficient production yields lower costs and the possibility of lower prices in return for increasing volume. Product differentiation might take the form of experimentation with different mixes of safety and amenity, and different forms for providing them. Research and development to achieve technical progress in either of these dimensions would be stimulated by the desire to keep abreast of competition, assuming it were coupled with adequate safeguards to assure a fair return to inventiveness.

The introduction of mandatory building codes distorts the incentives of producers. Each builder is constrained by the code in the extent and variety of methods he might use for cost reduction and product differentiation. Knowing

that all others are similarly constrained, however, he channels his innovative energies into types of activities which are not in the domain of codes - superficial decoration, financing, etc. - knowing that a normal return is possible. Only where codes appear to discriminate among producers will changes be actively sought. The transition from local codes - a form of market entry barrier - to uniform codes is a result of such a reaction.

Codes promote competition, on the other hand, by providing as a free good information and specifications on what constitute sound housing. As indicated in Chapter 3, this aspect, by lowering fixed costs, allows a large number of small firms to operate. This effect may be somewhat offset, however, by the greater unit costs associated with compliance for small builders. Large tracts of housing comprising a few models involve less time in review of plans and inspection than do residential structures built individually.

The problem of "moral hazard" has also been alluded to previously. A likely result of the building code system is that consumers may take greater risks to their safety because of possibly higher standards than they would choose themselves and because of the cheaper insurance rates which result from the higher standards. A very large proportion of deaths

stem from occupant negligence.* Much of the effort directed toward reducing this source of accident has been in the form of educational materials frequently produced by insurance firms or associations. There has been almost no progress in the development and use of non-structural safety devices. Fire extinguishers, a traditional device, are present in only a small proportion of residences, primarily large multi-family structures and seasonal homes. Smoke detectors, a recent innovation are only beginning to be introduced. In view of the pattern of cause and spread of residential fires, investment in home furnishings with greater flame-retardant properties might be more cost effective than many of the provisions in building codes. In all three cases, code-formulating and standard-setting bodies tend toward mandatory use or installation, without any offsetting reduction in structural requirements.** Such a substitution

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* The Ontario Fire Marshall attributes 37% of fire incidents, residential and non-residential, to this cause (56). A U.S. study, similarly, cites as the cause of over 50% of deaths resulting from residential fires "a cigarette left burning on a sofa while the smoker falls asleep" (29, p. 266).

** The bias created toward mandatory structural as opposed to discretionary non-structural solutions is illustrated by the mandating of hard-wiring of smoke alarms in new construction in the NBC.

process, if it were allowed to function, could provide a considerable impetus for the development of non-structural safety features which could substantially reduce the marginal cost of safety. In addition, the moral hazard problem might be somewhat ameliorated if greater potential risk were accompanied by greater discretionary opportunities, especially if these were reflected in differential insurance rates and an associated increase in co-insurance. Changes in levels of safety for the population as a whole could therefore be achieved much more rapidly by a non-structural feature representing a quantum increase in safety per dwelling than by a structural feature capable of effecting the same increase. The latter can be introduced only gradually, because they are embodied only in new construction and renovation. More widespread ownership and replacement by technologically advanced devices would also be facilitated by their relatively low replacement costs and lesser durability in use of non-structural compared with structural features. Combined with the greater discretion associated with more emphasis on non-structural features, adaptation to changing social norms could also be expected to be more rapid.

In general, building code requirements have become increasingly

more complex and more costly over time. In an internal analysis of the 1978 revisions to the Housing and Small Buildings section of the provincial code, the Ontario Building Code Branch identifies seven changes as probably increasing costs, while only three would be expected to decrease costs and ten would not cause significant change. No estimate was included of the net impact in a typical new housing unit. Interestingly, the predominant tendency in changes to parts of the code dealing with non-residential, and to a lesser extent large residential structures, is toward reducing costs - at least as judged by numbers of code changes. Fifteen cost-decreasing changes have been made, versus five which increase costs and two expected to have no significant impact. These changes pertain to the Use and Occupancy and the Building Services section of the Code.* They include options for alternative building features to achieve common ends, e.g., sprinkler systems versus a structural arrangement and materials to prevent the spread of contaminated air during fires. Such options are by and large lacking in the provisions pertaining to small residential buildings.** This apparent tendancy toward cost-

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* It should be noted that the 1978 revisions, the first since the introduction of the uniform provincial code, reflect both changes between the 1975 and 1977 versions of the NBC and departures between national and provincial codes.

** There have been some notable exceptions to this generalization, such as allowance for roof trusses to replace traditional joist and rafter construction, and the elimination of requirements for corner bracing.

saving changes in non-residential and large residential structures versus cost-increasing changes in small residential structures reflects the greater sophistication of the owners and managers of the former type of structure. The impact of code provisions on original purchase cost and operating costs are more clearly recognized. Hence, there is an incentive for builders to seek the introduction of more liberal requirements in this sector than in small residential buildings.

iv. Structure of ACNBC

An examination of the structure of the ACNBC indicates the problem of adequate representation of consumer preferences in the formulation of building codes. The organization of the Committee and its relationship with the provinces, the Division of Building Research and the parallel committee dealing with the National Fire Code are shown in the diagram on page 4-(14).*

Each Standing Committee is responsible for one, or for several closely related parts of the NBC and associated codes, standards and supplements. The Standing Committee

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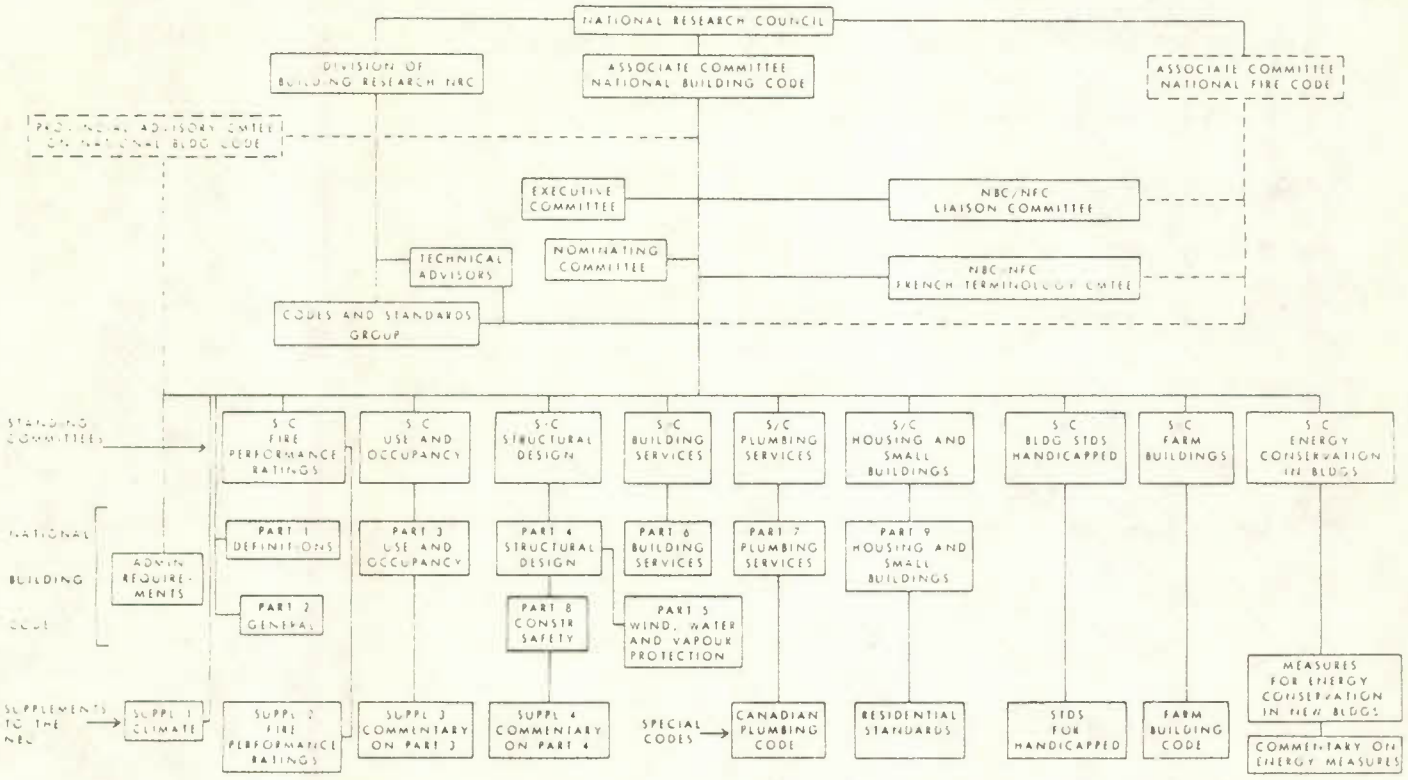
* The diagram is reproduced from (59), which presents a detailed exposition of ACNBC's structure and procedures.



Associate Committee on the National Building Code organization chart

may appoint Revision Subcommittees responsible for investigating possible changes in the Code and recommending revisions to their respective Standing Committees. The Subcommittee may in turn appoint temporary Task Groups to investigate specific items or subject areas. The composition of each Standing Committee is intended to reflect three sectoral interest groups - regulatory, industry and general interest. The regulatory interest is represented in most of the committees by building and fire officials (provincial and municipal) and by federal

departments with regulatory responsibility, such as CMHC and the Dominion Fire Commissioner's office. Industry representatives are drawn from firms or associations of firms engaged in development and construction and in manufacture and fabrication of building materials, equipment and components. Architects, engineers and research and testing laboratories account for most of the general interest representatives.

Two comments might be made, relating to our preceding discussion. First, the ACNBC and its component subcommittees are constituted in a way which is consistent with the achievement of safety by means of features of the building structure. Opportunities for non-structural approaches, and their substitution for code-embodied structural features are effectively beyond the competence of the ACNBC itself. Through its liaison with the Associate Committee for the National Fire Code, including overlapping membership on standing committees, there is a limited opportunity for such substitution. The

National Fire Code concerns itself, among other things, with fire drills and evacuation procedures and use of fire extinguishers in high-rise residential buildings and in rooming houses and institutionalized residential situations. The major impact of NFC provisions on residences is, like that of the NBC, upon structural features, however. A large share of the provisions of the NFC are elaborations of NBC provisions, but pertain to previously-occupied rather than newly-constructed units. Insofar as provinces and municipalities adhere to the system based upon NBC, NFC and associated standards, and insofar as these standards produce safety levels which reflect social choice, reliance upon consumer-supplied devices and safer behaviour patterns are mitigated.

Second, the composition of NBC committees appears to be biased against consumer interests. Taking the Standing Committee on Housing and Small Buildings as an example, only one of the twenty members represents "consumer protection interests". This member is drawn from one of the home warranty plans. Currently, such plans exist throughout Canada. Each of them covers one province or, in the case of the Maritimes, a group of provinces. Participation is mandatory for all builders in Ontario and for all new house construction for which mortgages

are insured by CMHC or the private-sector insurors, regardless of location. (60)(61). The individual plans are each administered by boards appointed by provincial councils of HUDAC. Consequently it is questionable whether "consumer protection interests" are well represented by this member, any more than they are by the direct representatives of the building industry, particularly since he is sensitive to potential cost effects and loss of goodwill toward the building industry generally from dispute arising from low-quality construction materials and practices. The remaining representatives of the General Interest - architects, engineers and a structural specialist - are concerned with sound construction and are conscious of cost implications, but would appear to have no special incentive to reduce standards or allow for substantial departure from conventional practices. Of the Industry members, builders' objectives have already been discussed. Building products manufacturers might wish to facilitate the introduction of new products, but equally might be opposed to the replacement of their own, traditional products. Of the Regulatory members, mortgage insurance officials, similar to the home warranty plan representative, are concerned with minimizing default; hence, would tend to press for high standards. Fire and building officials,

concerned with code enforcement and conscious of potential abuses by builders and building owners, are likely to be the most conservative of the constituent members,in the sense of favouring very high standards. Certainly they are the only members whose professional roles are mainly or entirely the result of the existence of building and fire codes.

In addition to its effect upon housing costs by means of specifications involving health and safety features, there is a possibility for increased costs via what might be termed "the portmanteau effect". Given the existence of a mechanism for regulating building, it may be used to promote ends other than health and safety. Thus, a former Director of DBR noted: "there is a growing tendency .. to allow matters of amenity, including appearance and quality, to creep in" to the NBC (7, p. 3). DBR staff members have also argued publicly that building regulations should be expanded to reflect energy conservation objectives (12). While either of these extensions of the building regulatory system might be efficient relative to other means, there is a danger that the mere existence of the governmental mechanism will lead to the neglect of alternative courses of public action.

C. Optimal Jurisdiction

The problem of the most appropriate division of responsibilities among governmental jurisdiction in the formulation and enforcement of building codes is an integral part of the question of efficiency in resource allocation in the delivery of public services. It has been treated in the building code literature as virtually the only efficiency problem. In part, this concern may reflect the U.S. experience, which is in some important respects inapplicable to Canada. The thrust of building code reform in Canada has been in the direction of uniformity. This development is understandable, if we accept the conclusion that code formulation is weighted in favour of the building and associated industries. Greater uniformity, as discussed in the preceding chapter, effectively reduces entry barriers to local markets, benefitting particularly large firms. Other possible directions for building code reform have more ambiguous results in this regard.

The problem of optimal jurisdiction, particularly in the context of the metropolitan area, which corresponds with the local housing market area, has been treated theoretically by Rothenberg (51). Assuming individualistic welfare

criteria apply to the public sector, the delegation of power to political jurisdictions should be done in a way that minimizes the redistributional effects of majority rule. At the extreme, each individual would constitute a jurisdiction; but this solution runs counter to three efficiency objectives: first, achievement of economies of scale in the production of public output, second, the reduction of "political externalities", by which the policies of one jurisdiction affect the residents of another; and third, the redistribution of income. While the sizes of optimal jurisdictions depend upon the facts of the situation, it would appear "that the degree of political decentralization which maximizes consensus generates units considerably smaller than what is efficient for public output production". Another way of viewing the problem is in terms of a jurisdiction with a portfolio of instruments available to achieve a variety of objectives for its constituents. The optimal mix of different instruments employed to achieve these objectives will depend upon their marginal efficiencies; but these in turn may be affected by the size of the jurisdiction, as well as the actions of neighbouring jurisdictions. Arrangements could be made between jurisdictions or imposed by a higher-level jurisdiction by which functions are performed individually by special-purpose bodies. Carrying

this approach to the extreme of dividing all public functions into single-purpose jurisdictions, however, would be highly inefficient.

Turning from these theoretical models to the question of the appropriate jurisdictional setting for building codes, several important features are apparent. First, activities associated with building regulations are of two principal types - those associated with formulation and those associated with enforcement. The former involves both the application of expert technical knowledge from a variety of specialties associated with construction and, for testing, specialized and expensive facilities and equipment. The substantial fixed costs of this set of activities has provided the basis for centralization in the Division of Building Research and its direct tie-in to the formulation of a single national model code. For the same reason, de facto acceptance of the provisions of the NBC has been almost universal at the local level. In its 1969 report, the Committee on Uniform Building Standards for Ontario (19) listed 368 of the 648 municipalities responding to its questionnaire as using the NBC as the basis for their local codes. These municipalities accounted for 83% of the population of respondent municipalities, which in turn represented 89% of the province's

population. A calculation based upon the figures shown in the report indicates that two-thirds of the total number of building permits issued in 1968 were in municipalities which used the NBC as a basis for their codes. The situation prior to the adoption of provincial codes was similar in at least one other province, Alberta (65). The transition to a system of provincial codes, while it will inevitably lead to still greater uniformity within provinces (with minor variations being allowed as the result of climatic and other environmental differences), also has the potential for greater variations among provinces, resulting from the capture of scale economies in code formulation (costs relative to numbers of units affected). It is still too early to tell whether provincial codes will diverge significantly from the NBC. Initial versions have been very close to the national code; but this reflects in part the considerable initial effort in setting up provincial counterparts to the national system. Once in place, the provincial systems can be expected to undertake continual revision, much as occurs with the ACNBC, leading possibly to substantial divergence from the national code, or to modification of the national code to make its provisions acceptable to the provinces. An early instance is provided by the issue of smoke spread in high-rise buildings. The NBC provisions were opposed primarily by

developers of high-rise buildings in Ontario on grounds of inadequate safety enhancement in relation to the expenditure entailed. They attempted to convince the province to modify or delete the requirements on all high-rise construction. They succeeded in having the requirements dropped for apartment buildings. They may subsequently be introduced, however, as the result of further investigation by ACNBC with a view to modification as part of the 1983 revision for the NBC. This instance illustrates also that the provincial building code agencies are likely to become an alternative channel for changing provisions which are undesirable to particular interests. This gives a further advantage, especially to industry interests, over the more decentralized local code system, under which achieving such a change would have required distributing resources among a large number of local jurisdictions.

While provincial codes may evolve in a manner such as to reflect differing regional consensuses regarding the make-up of regulations - subject to greater unit costs of testing and formulation than at the national level - they represent a significant change for some communities within the respective provinces. Previous to the introduction of provincial codes, municipalities had access to both types of building code activity - formulation and enforcement. The former of these has been

removed by the creation of mandatory provincial codes. The impact may be seen in terms of three classes of municipalites - those which previously adhered entirely to the NBC, those with generally higher standards and those with generally lower standards. By transferring the power of code formulation to the provincial level, the preferences of relatively conservative and relatively liberal communities (assuming these to be accurately reflected in locally formulated codes) are overridden in favour of the preferences of the larger population. Thus far, open resistance to the change has been limited to the relatively conservative communities. In a recent landmark court decision, a municipality in the Ottawa-Carleton area was enjoined from enforcing a by-law which effectively would have imposed a more stringent standard pertaining to party walls than is specified in the provincial code (74). The plaintiff was a builder, whose economic motivation in seeking adherence to the uniform code should be clear from our previous reasoning. The issue is being pursued, however, by a group of building officials representative of the more conservative communities. At this stage, the controversy could be resolved only by a change in the provincial code. It is noteworthy that the conservative group appears to be attempting to influence the process of change by appeal to a broader set of decisionmakers than those directly involved in code formulation.

Communities with a relatively liberal tradition of building regulations have not been as adamant in their resistance to the stricter standards. There are at least two reasons. Referring again to the Ontario Uniform Building Standards Committee's report, the bulk of municipalities which either were not using the NBC or which had no building laws were townships. Much of the building activity in these municipalities was probably in cottages, the conversion of cottages to year-round dwellings and the construction of dwellings on farms. Cottages and cottage conversion are covered, in the Ontario Code (Sect. I.37) by a less stringent set of regulations. Farm Buildings are covered by a separate Farm Building Code. Thus, the lower standards consistent with the preferences of rural residents are to a considerable extent already reflected in the uniform code. Another reason is related to the second aspect of building code regulation: enforcement. While documentation is difficult to provide, it is well known among building practitioners - as reflected in comments in the Ontario report and by persons whom we interviewed - that code enforcement is less stringent in rural areas. In part, the lower standards result from higher unit costs of enforcement in areas of sparse settlement and jurisdictions where the volume of construction is low. They may also reflect the tastes of

the population residing in these areas. Enforcement thereby becomes a non-codified means implementing local levels of acceptability.

In general, then, vesting localities with building regulation powers allows households mobility among jurisdictions so that, subject to other locational characteristics such as accessibility to jobs and quality of public services, they are able to choose some minimum level of housing quality consistent with their budgets. This view is consistent with the theory of public goods delivery in a metropolitan area by which members of the population, by "voting with their feet" determine the relative levels of public services and neighborhood quality. A number of the Ontario jurisdictions which had the most stringent standards prior to the imposition of a uniform provincial code were townships and boroughs in rapidly expanding portions of metropolitan areas. This stringency may reflect a desire to minimize negative neighborhood externalities - from fire spread and lower-quality housing - impinging on existing properties. The costs are borne by the purchaser of new housing who, up to that point has no voting power (assuming he moves to the municipality from elsewhere). The result is indirectly, but perhaps consciously, to deter the entry of lower-income households into such communities.

Stringent building codes may, in this regard, be reinforced by an array of development and land-use controls, as well as regulation for fire protection, which is still largely in the municipal jurisdiction. * The efficiency and redistributive aspects of provincial jurisdiction versus national jurisdiction in building regulation are analogous to those pertaining to provincial versus municipal jurisdiction. The major difference is that interprovincial migration is unlikely to be significantly affected by disparities in regulations. Formal national jurisdiction does not appear to be feasible under the present broad distribution of powers; however, the situation prior to the adoption of provincial codes was one in which the NBC was adopted whole or with only minor revisions by municipalities representing a large share of the population, although with some constraint by their respective provinces. The comparison therefore has an historical correlate.

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* At the time of the 1969 report, for instance, Ontario municipalities were prevented from adopting the National Fire Code. At this writing a provincial code has been drafted and is being circulated for comment before revision and adoption. "In addition, all provinces exercise directly the right to legislate for safety in such matters as the distribution and use of electricity, gas and oil, control of fire hazard in certain public buildings, and such specific items as boilers, pressure vessels and elevators. These statutes naturally take precedence over municipal building bylaws when they are more restrictive." (7, p. 3).

The role of provincial building regulatory agencies may be viewed as one which represents the divergence of preferences of regional populations from those of the national population as a whole. These divergences are embodied in differences between the NBC and provincial codes. There are two dimensions in which provincial jurisdiction might improve (in a Pareto-efficient sense) upon a single set of regulations formulated at the national level. First, and analogous to the argument at the local level, consensus should be easier to obtain at the provincial than at the national level, i.e., conflicts among "regional interests" are reduced accordingly as the population of the jurisdiction is reduced. Second, insofar as there are distortions, in aggregating preferences at the national level, favouring one sector over another, such a bias may be corrected by compensatory action at the provincial level. An examination of interest groups represented on the Ontario advisory committee and otherwise consulted with regard to building regulations *, however, produces virtually the same distribution of interests - and in many cases the same organizations - as are present in the various standing committees of the ACNBC. These include organizations representing materials, equipment and utility manufacturers

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* Listing supplied by the Ontario Building Code Branch.

and suppliers (12), builders, developers and contractors (12), architects, engineers and designers (7), labour unions (1) and building, fire and municipal officials (8). Consumer interests are represented only by owners of large buildings. Thus, it appears unlikely that any bias in favour of producers, and consequently in favour of higher than optimal construction standards and costs would be corrected at the provincial level. On the contrary, a bias would probably be aggravated.

Chapter 5: Framework for Benefit-Cost Evaluation

A. Introduction

It will be attempted, in this concluding chapter, to establish a framework for evaluating the benefits and costs of the building code system. It is not possible, at this stage of investigation to produce a full-scale benefit-cost computation. Rather, we shall emphasize methodology - the problems and possible approaches to achieving such quantification. The discussion also serves as a summary of the reasoning developed in previous chapters. Where possible with the time and resources available to us, we have included figures pertinent to the individual items in the framework. These may serve to give some sense of potential savings from more efficient resource deployment and income redistribution within the population.

B. Intertemporal Comparisons

In order to measure the net gains to society from a system of building codes it is necessary to consider differences over time. Indeed, since building codes are not concerned with a single "project" but with the

properties of all new construction and renovation, only the flow of inputs and outputs over time is relevant. New construction and renovation as well as services related to building and residence will in general display different time profiles for the building-code and the reference alternative. Comparison of these different streams will require application of an appropriate discount rate to convert them into a present discounted value.

In general, we may think of two situations: one in which building codes are prevalent, and the reference situation, which might be specified in a variety of ways. We can summarize the calculation of benefits and costs in the following formula :

$$\sum_{\tau} (\Delta HS_{\tau} + \Delta BI_{\tau} + \Delta HD_{\tau} + \Delta CI_{\tau} + \Delta RBC_{\tau}) * e^{-r\tau}$$

where

$\Delta HS\tau$ = safety in housing, in terms of the difference in value between the building code and reference situations, during period τ

$\Delta BI\tau$ = indirect benefits, etc.

ΔHD_{τ} = direct costs, etc.

$\Delta CI\tau$ = indirect costs, etc.

ΔRBC = redistributive effects, etc.

$e^{-r\tau}$ = discounting factor, where e is the base of natural logarithms and r is the discount rate

The first four terms are simply aggregates of the values, aggregated over individuals, of the various component benefits and costs, while the term RBC accounts for the value placed by society upon redistribution of income resulting from the change from the reference to the building code situation.

An important set of benefits and costs are embodied in the housing structure. These are both the result of changes required by codes and voluntary changes made by owners at the time of new construction and renovation or as maintenance. Insofar as building codes affect the useful life of housing structures, they also affect the time span over which such benefits and costs are to be measured. Assume that society sets a norm for housing safety which is enforced by building code requirements for minimum standards, and is invariant from some point in time (τ_0) forward. Assume also that at τ_0 some portion of the housing stock falls below this norm in one or more dimensions. Over time, the mix between standard housing (which may in some or all respects exceed the norm) and substandard housing will depend upon the relative rates of addition to the stock in the form of new units, upgrading by renovation and removal of units, by demolition or by conversion to non-residential occupancy. Using a discrete approximation

to the continous process:

$$\Delta PSH = (NC + RN + RMSS - RMS - DET) / H$$

where

ΔPSH	=	change in proportion of housing units meeting all safety requirements of building codes
NC	=	new units added by construction and net new units by conversion (mergers and subdivision of existing units)
RN	=	units brought into conformance with the code by renovation
RMSS	=	sub-standard units removed from the stock
RMS	=	standard units removed from the stock
DET	=	number of standard units falling below code standards due to physical deterioration
H	=	total housing units

Unless standards are set at a low level, their creation will leave society initially with a mix of standard and sub-standard housing. Over time, the housing stock will approach total conformance with the minimum requirements, if removal and deterioration of standard units combined are less than the other components of change. If standards rise over time, an additional component must be introduced - the movement of housing units into the substandard class as a result of such re-definition even though, by any objective standard of safety, their

characteristics are unchanged. The above formulation deals with numbers of housing units above or below minimum standards, and not with the total amount of safety. Changes may be made to housing units which make them more or less safe but do not alter their conformance or non-conformance with codes. Further, the use-characteristics of housing which affect safety are left out of consideration in the formulation. Increased loading of the dwellings systems may lower the units' ability to provide safety, while occupancy by smaller households may increase it, etc.

C. Quantification of Elements

i. Reduction of loss of life and injuries

There has been a considerable volume of literature recently on the evaluation of life and limb in relation to benefit-cost anaylsis, or as it is termed especially in relation to possible catastrophic occurrences such as nuclear explosions, risk/benefit analysis. See, e.g., (14), (15), (16),(17). These and other administrative costs under the building code system must be compared with private, or a mixture of private and public costs which would pertain to the reference case. These would include primarily costs

of insurance and of litigation, both of which might be expected to be broadened in scope in the absence of codes. Property and casualty insurance may be considered relatively expensive in terms of premiums versus expected repayment resulting from claims. In a recent year, the ratios of claims paid by insurance companies to revenue from premiums ran, for these types of policies, in the 55 - 65% range. This was described as a disastrous year by an industry spokesman.

A variety of methods have been employed for estimating the value of the reductions in loss of life and in injury resulting from the measures under study .* These are of four types: the present discounted value (PDV) of the person's expected future earnings; the PDV of his excess of earnings over consumption; the implicit value attached to life and injury by various social expenditures; and the insurance premium he is willing to pay, related to the probability of death and injury. All of these approaches have been reviewed by Mishan (28) (48, pp. 298-309).

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* We assume, to simplify the discussion, that the increment in safety compared with a market-oriented solution, is positive. This may not be the result, however, as has been argued in the previous chapters. The reasoning still holds, however.

His crucial objection to all of these methods is as follows:

> ... not one of them is consistent with the basic rationale of the economic calculus used in cost-benefit analysis. If we are concerned ... with increasing society's satisfactions ... we can always be guided in the ranking of alternative economic arrangements by the notion of a Pareto improvement - an improvement such that at least one person is made better off and nobody is made worse off.

He goes on to discuss the concept of a compensating variation (CV), being the maximum sum the individual would be willing to pay, rather than go without the project or governmental action in question - a measure of his increased welfare. If a person is made worse off, his CV measures his decline in welfare as the minimal amount he would be willing to accept to put up with the project. The rationale behind this approach is that if net gains, as measured in this way, are positive, they may be re-distributed in such a way that at least one person is better off while nobody is worse off.

The use of this approach, although it may involve very crude and indirect measurement, is still superior to the alternatives listed above. Some of these alternative may have a surface plausibility for limited application.

Two studies of building safety (33) (35) follow the third of the four alternative approaches listed above. They develop calculations of lives saved, in probabilistic terms, per dollar of net cost, on the assumption that all significant costs and other benefits have been monetized. Equivalently, an implicit minimum value of life and limb can be placed upon the specific measure to justify its implementation, i.e., the value of net costs. This approach is advocated by the authors for comparing and ranking two or more alternative projects or measures. The one with the lowest implicit value of human life necessary to justify the project would be judged most desirable. This approach is open to the objection, however, that it implies the value of all lives to be equal, whereas individuals' choices would in general reveal their own evaluations to differ, and different safety measures would affect the probability of death or injury differently for each person. Furthermore, adding together the ex post monetized value of all other benefit and cost elements - to re-iterate the Mishan argument - is not an adequate substitute for adding together the amounts which people would be willing to pay or would require as compensation, on the basis of their own subjective estimates of the

probability of death or injury. In a situation, such as building codes, where expenditures for particular purposes are imposed, it is paternalistic to insist that such expenditure reflects the value derived by individuals. Both in the evaluation of benefits of greater safety and of other benefits deriving incidentally from building codes the notion of compensating variation should be employed.

ii. Indirect benefits

Indirect benefits are of two types. The first is derived from the increment in amenity and durability offered by the housing unit as the result of codes' minimum standards. As with safety, this increment may be positive or negative, depending upon the relative efficiency of building codes and the market oriented alternative in providing these outputs.

The second type is generated by external effects. The first of these, as discussed in Chapter 2, is associated with the risk to one's own life, limb and property resulting from the spread of fire from, or structural collapse of a neighbor's dwelling. We might also add neighborhood appearance, insofar as this quality is influenced by codes, which affect the quality and type of housing.

To achieve a given level of safety, in terms of probability of death, injury and property loss, a more costly structure is needed in an area where one or more surrounding buildings are fire-prone or structually unsound than in an area where all buildings are relatively safe. When code requirements are increased, direct costs are also increased (since more people must spend more than they would voluntarily) while indirect costs are decreased (since fewer people need to add on safety features to protect themselves from the

dangers of their neighbours' unsafe housing). Any alternative to building codes which did not provide some form of deterrent to the construction of unsafe housing would almost certainly increase indirect costs substantially. Some idea of the magnitude of the problem can be gained from the Ontario fire statistics for 1977 (74, p. 29). Of 19,000 incidents classified by extent of fire (residential and non-residential structures) nearly 600, or 3%, extended beyond the building of origin, while $23 million, or 15% of the value of loss was sustained in such fires. The value of loss figure includes the building of origin, which probably accounts for most of the amount. Nevertheless, in the housing stock as it exists, damage by spread of fire from one building to another was significant.

The other two sources of external effects are the risks associated with re-purchase and the "altruistic" effect, whereby the individual's welfare is increased by an increase in safety for all other members of society. The consumer derives "psychic income" from the knowledge that all housing units other than his own are at least minimally safe, and that all other households are safely housed.

iii. Reduction of social service costs

Insofar as building codes reduce the incidence and potential severity of fires and structural failure and promote healthful living conditions, they reduce the requirement for substitute social services. The most obvious of these is fire control. The combined costs of fire departments and property loss from fire are substantial. They run at about $40 per capita in the very urbanized portions of Ottawa-Carleton, and at about $30 per capita in the suburban and fringe municipalities.

iv. Costs of Construction

A number of studies offer illustrative figures of the costs of a variety of features required under building codes. In one U.S. study (cited in 20, p. 100) an estimate of "less than one percent of money spent for housebuilding was attributable to known code inefficiences". Another estimates "savings for reducing rigidities in building codes ... represent from 1.5 to 3 percent of the price of an average house" (20, p. 102). No equivalent estimates appear to have been made for Canada. If we apply a factor of 2% to requirements of approximately 220,000 units per

year between 1979 and 2000 as projected in a recent CMHC study * (75) and if we assume an average value of $69,000 per unit in 1979 dollars over the period, being 25% higher than the actual 1978 figure **, the average annual additional expenditure is $304 million. Any such figure should be adjusted by the (positive or negative) increment in property losses resulting from the building code system, net of the value of replacements required for units destroyed by spread of fire in, or collapse of neighbour's dwellings, which we have accounted for under "Indirect Benefits".

There are several problems associated with these types of estimates. First, the two U.S. studies cited are concerned with the cost impacts of "unreasonable" code provisions in a situation of local code formulation, as compared with a "reasonable" uniform code. This information is of interest to us in comparing uniform and local code regimes.

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* The CMHC projections show a gradual decline in housing requirements from 263,000 in 1979 to 164,000 in 2000.

** Per-unit value in 1978 of $55,300 is calculated as value of housing construction ($13.6 billion) from (2) divided by housing completions (246,000) from (3). The value figure includes repairs of $2 billion. Major repairs are also affected by building codes. It is assumed their value will vary at the same rate as new construction.

It does not, however, address the question of cost increments *per se* of codes.

Second, the estimates are of an *ex post* nature, i.e., they measure prices and costs as they exist with a particular system of building codes in place. Under an alternative, market-oriented system, (e.g., our reference system) the resources required to produce a specific combination of levels of amenity and safety associated with the housing package may be higher or lower. Both the technology of production and the set of relative prices of factor and material inputs may differ. It is asserted that building codes per se, or variations in codes amongst jurisdictions constrain builders and off-site fabricators from operating more efficiently. There are three aspects of this presumed increase in efficiency. First, suppliers of inputs to housing production would be able to produce goods and services at lower unit costs, e.g., because of the larger size and stability of customer firms, reducing expenses of marketing and stockage. This argument presumes an altered market structure for housing producers. Second, technologies now known but unexploited or under-exploited because of code restrictions and testing requirements might become widespread. Third, through research and development, the set of available technologies might be expanded. These three developments combined might reduce

housing costs by significantly more than the percentages estimated in the above citations. On the other hand, even a completely market-determined system would presumably contain a host of safeguards to reduce risks and externalities associated with "free riders" of one type or another. Hence, many of the "costs" of building codes may represent, not wastage, but a devotion of resources yielding marginal returns, as safety and amenity, equal or greater than what might be expected under any alternative system.

A third problem is that findings of "excessive" structural requirements reflect primarily builders' opinions as to efficiency in producing safety. Insofar as some elements of building codes result in significantly lower increments to safety per dollar of extra cost than others, the contentions may be valid - bearing in mind the difficulty of separating out such effects in the interdependent system which is the housing structure. This is partly an engineering question, about which we cannot make judgements. If the consumer were to decide, however, that the additional costs were warranted by the increase in safety, they could not be termed excessive. The question is this. Does the interposition of

public decision-making, by reducing unit costs of information, and by internalizing externalities, yield a net benefit in terms of what the consumer is willing to pay for the resulting safety level (for himself and the rest of society) compared with the amount he would be willing to pay under an alternative, market-oriented scheme which in general would yield a different level of safety and would involve information, enforcement and other types of transaction costs. In other words: do the (allegedly higher) levels of safety and costs resulting from the building code system reflect more accurately society's valuation than do those advocated by the builders. Evidence relating to these hypotheses in existing studies is sparse and indirect. In a U.S. study (73), Sims demonstrates, by a variety of measures,a rapid rise in construction industry productivity between 1947 and 1965. Over roughly the same period, figures cited by the Economic Council (69, p. 63) also show substantial growth in output per man-hour, especially during the 1950's and late 1960's. Both these conclusions, because of limitations of the data, pertain to construction as a whole, rather than residential construction specifically. Moreover, such measures reflect mainly on-site activities to the neglect of machinery, material and off-site component manufacture, all of which may be contributing increasing shares to the vertical chain of production resulting in the finished dwelling. See Sims

for a discussion of this and related points. Nevertheless, it may be stated that, even in the presence of building codes with an extent of variation such as existed over this period, the industry was able to adapt its technology so as to increase efficiency significantly. Unfortunately, this observation leaves us with the unanswered question as to whether the change from local to uniform codes or from uniform codes to a market-oriented system results in significant additional improvements in productivity growth and a consequent reduction in prices.

The Council notes that, of the three major types of inputs to construction, improvements in equipment are diffused most quickly, in materials less quickly, and in methods (except within localities, where they spread rapidly) least quickly. Codes, and in particular inter-jurisdictional differences in code requirements are cited as inhibiting the diffusion of new materials. It is implied, then, that the move to uniform codes will have the effect of increasing the rate of productivity growth by more rapid diffusion of new materials. In addition, any significant influence,either of a change to uniform codes or from uniform codes to a market-oriented system, by changing the industrial structure of residential construction, may enhance diffusion of all three types of input. In the case of a change to uniform codes, the

inhibiting effect on innovation and diffusion of the need, either to differentiate the product to conform with regulations in individual municipalities or to incorporate such high standards in a uniform product as to make it conformable with all local variants, is obvious. Less obvious, perhaps, is the mechanism by which costs might be reduced in a market-oriented system. As pointed out in Chapter 3, an expanded set of alternatives for production technology could be expected to result from additional trade-off possibilities between structural features and costs consistent with a given level of safety. This expanded set of possibilities would have three results: better utilization of materials at each establishment size, increased scale of production, as larger firms are better able to spread the costs of innovation over larger production runs, (an effect which may also be expected from the move to uniform codes), and, as the result of larger-scale production, more focused demand for innovations by the industry and its suppliers.

v. Indirect costs

Indirect costs of construction are those costs not directly required by building codes, but which ensue from such requirements. Heavier gauge materials, larger sizes, etc., than might otherwise be employed may in turn require larger clearences, heavier supports, etc. * In the extreme, builders may shift from one type of construction to another or one type of dwelling unit arrangement to another (double vs. duplex, etc.) in order both to reduce the direct costs and the indirect costs of code provisions.

vi. Administrative and legal costs

The administrative costs of building regulations through codes are associated with formulation, at provincial and local levels, enforcement of compliance in the construction phase, and of post-construction compliance, primarily by fire department inspections. We have attempted to compile figures for municipalities representing the bulk of permit activity in the Ottawa-Carleton area as follows. Of four

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*An example provided by one interviewee was of the requirement for venting pipe of an outside diameter too large to fit into the drywall which would otherwise be installed.

municipalities surveyed, only one, Nepean, was able to give us figures in sufficient detail for our purpose. In 1978, 200 permits, involving 1,206 new housing units were issued, with an aggregate value of $37,800,000. In addition, 251 permits were issued for $1,763,000 of renovation. Apportioning the building department's budget, which amounts to 0.35% of the total municipal budget, according to the relative values of residential and non-residential construction, expenditures by the municipality amount to 0.3% of the value of residential construction and renovation. Fees payed by builders are 0.5% of construction value. These figures may be representative of urbanizing areas on the fringe of large metropolitan areas.

vii. Income distribution

We shall make no extensive discussion of the income-redistributive aspects of building codes, other than to list several points made in earlier chapters. Assuming safety in housing to be a superior good, and assuming also a stable level and price of safety over time, the impact of building codes, in terms of distortion of the consumer's

expenditures would appear to be greatest for lower-income households. Their preferred level of safety is more likely to fall below the minimum requirements. Only with rapidly rising income levels might the high marginal cost of safety improvements to existing structures place a relatively greater burden on higher-income households. In addition, the share of housing in the expenditures of low-income households is greater, and codes are assumed to raise the price of housing generally. Historically, however, building requirements have become more stringent and costly. Purchasers of new, and renovators of old housing bear a greater cost than those staying or transacting in the older stock.

Re-distribution may be accomplished through the tax system. If building codes have the effect of raising the level of resources devoted to housing, and if tax rates are not lowered to compensate for the increased base, the increased yield would be available for a variety of collective and other services unrelated to the income of recipients or skewed toward the low-income end. If the net effect of codes on property valuation can be identified, then this source of re-distribution can in principle be estimated from the distributive characteristics of local government services as a whole.

D. Summary and Recommendations for Research

i. Introduction

In the preceding sections of this chapter, we have suggested, where possible, the order of magnitude of individual elements of benefits and costs of building codes, as well as indicating sources of information for such quantification. From this discussion, as well as the theoretical reasoning of the previous chapters, however, it should be clear that much more needs to be known about economic behaviour related to residential building regulation before any quantified evaluation of its impact can be made on a sound analytical foundation. In this concluding section, we shall identify four major problem areas which require research. While the discussion will be in terms of residential building codes, it should be understood that broader studies might be undertaken on the same subjects dealing with building safety generally, or the effects of various configurations of regulations, non-regulatory incentives, etc., pertaining to safety in buildings.

ii. Consumer behaviour

The evaluation of benefits derived from any program devoted to enhanced consumer welfare must include, if we are to assume an individualistic welfare basis, an assessment of what consumers would be willing to pay for such a program, or forego rather than lose it. Such an evaluation is extremely difficult in a case such as this, both because safety is not neatly separable from other services yielded by housing, and because information about safety levels of different housing units is costly to acquire, at least under our

currently-prevailing system.

The need is, first, for the construction of a model which deals adequately with the behaviour of consumers with respect to safety in housing. Second, the model needs to be implemented empirically. Two general approaches might be suggested for such implementation, both of which involve considerable problems. First, it might be attempted to examine variations in household expenditures attributable to differences in the various outputs of building codes. These would include both direct outputs, primarily the household's own safety, and indirect outputs, including amenity and durability of the housing stock and greater safety for others in the community - where such outputs are offered at different levels and display different prices. Such information would allow us to impute at least an approximate measure of the amount which consumers would be willing to pay (require as compensation) for the move to a higher (lower) level along each dimension. There is available a large number of observations, in the form of housing units with different levels of safety and amenity and of neighbourhoods and municipalities with different levels of neighbourhood safety. The plausibility of such a model of consumer choice is called into question by the difficulty, for the consumer, in judging variations in safety levels among housing units. At the empirical level, furthermore, there are three types of problems: disentangling and evaluating separately the features of housing units and neighborhoods which correspond to the outputs of building codes - especially safety; matching these with the appropriate household budget expenditures; and accounting for externalities, particularly the "altruistic" motive for which

no equivalent private transaction would appear to exist.

A second approach would be to interview individuals as to their preference, at given prices, for a variety of outputs attainable both under building codes and under any alternative system. The value of information per se might be evaluated by posing a set of questions relying on the individual's subjective judgement of safety levels associated with various alternatives. The problem with this approach is that the full range of considerations which impinge on the consumer's decision is difficult to replicate in the imaginary situation with which he is presented in such interviews. In particular, the emphasis on questions pertaining to safety could conceivably bias the interviewee toward greater risk-aversion than he possesses in real life.

iii. Housing supply

The third area of research is housing supply - both the production of new housing and changes in the flow of services from the standing stock. Here, it would be desirable, by the construction and testing of appropriate models to explain, first, the behaviour of builders with respect to changes in the physical characteristics of housing produced under different sets of regulatory constraints and the implicit effects upon safety levels of such changes. Second, the effects of alternative regulatory structures on production, in terms of market structure, technology and costs should be investigated. This work should include the investigation of relative costs of on-site and off-site construction according to different actual and potential regulatory regimes and degress of uniformity among jurisdictions.

iv. Alternatives to the present system

It has been proposed in this study that the outcome of the building code system as it exists be compared with the situation which would prevail in their absence, and in which some level of building safety might be achieved by a variety of voluntary mechanisms for obtaining information about safety, insuring against hazards associated with housing and by cross-payments to reduce free-ridership and compensate those suffering losses. This is the appropriate reference situation, since it relies upon the free choice of individuals, constrained only by their own resources, and therefore allows the imputation of consumer surplus.

For normative purposes, i.e., for guidance in public policy selection, however, a number of alternative systems should be considered, combining different types and degrees of control with voluntary action. Some of the features of these alternatives and the corresponding sorts of questions which they raise are as follows. First, relatively greater reliance might be placed upon non-structural safety, e.g., in furnishings, appliances, etc. What is the relative efficiency, i.e., marginal change in safety versus resource requirements of these two types of safety measures, and how would consumers respond to changes in relative prices associated with altered levels of safety embodied in these various types of goods? Second, the relative stringency of building codes versus other types of regulation might be altered. Again, what are the relative efficiencies? What is the likely outcome in terms of type of new housing construction and levels of maintenance in different segments of the standing stock? What would be the

difference over time in changes and distribution of safety in the housing stock, relative to the present system? If mandatory building standards were lowered, it may be assumed there would be an incentive created for suppliers to offer greater differentiation of insurance rates to correspond with different levels of risk. What types of system would be feasible, what would be their resource costs and how much of the population would be covered under various cross-subsidy schemes?

v. Measurement of safety

The discussion of safety in this study has been in terms of a potentially measureable attribute of the residential dwelling, in conjunction with a particular pattern of use. The establishment of a scale of safety against which actual housing-use configurations could be compared has never been attempted. Until such measurement has been made, however, empirical work of the kinds suggested in the preceding paragraphs would be very restricted. Conceptually, there would appear to be little difficulty in relating the incidence of death, injuries and property damage and destruction in dwellings to a variety of characteristics of the dwelling and its occupants. In practice, we have the beginnings of a statistical basis for evaluating incidence; but considerable work on data collection and organization might be necessary to provide an adequate basis.

vi. Conclusion

A considerable amount of research and data collection would be necessary to deal with the questions we have raised in this

study. That so little has been done to date in this area can probably be explained by the removal from the public as individuals of the opportunity to choose consciously levels of residential safety and placing the responsibility in the hands of the collectivity, effectively of technical experts. Consequently, issues related to the provision of residential safety have been conceived in engineering terms, rather than as choices of the form and degree of regulation relative to individual choice. Hopefully, this study will provide a start in the direction of this much-needed economic investigation.

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