Building Codes and Housing

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Introduction and Summary

This paper considers the regulation of housing construction (single-family, multi-family, new construction, and rehabilitation of existing buildings), focusing on the building code (a broad term specifically defined in this paper). The building code is first described and its history is traced. History is particularly important with respect to the building code because it has been shaped by numerous events and disparate parties and currently is in a state of evolution; instead of three regional-oriented model codes influencing local building code regulations, there is now a shift toward two national model templates still influencing local regulations.

In theory, the building code could adversely affect housing production and could increase housing costs through both substantive (technical) and administrative impediments. The former include, as examples, restriction of cost-saving materials and technologies and barriers to mass production; the latter encompass such barriers as administrative conflicts between different administering parties (e.g., building and fire departments) and inadequately trained inspectors.

The literature on the subject of building codes and housing presents many examples of the above-described impediments. The various studies find that code inadequacies increase the cost of new housing from roughly one percent to over 200 percent. The more quantitative analyses are at the lower end of this spectrum and find code-related housing cost increases of five percent or less.

The literature to date is informative, but has gaps with respect to timeliness, conceptual basis, methodology, and scope. Much research is dated, describing the code world of yesteryear, rather than the current situation of two national model codes influencing the regulations. Conceptually, there is limited "benchmark" and cost-benefit study to define what are "appropriate" versus "inappropriate" or "excessive" regulations. Further, most reports on the subject are characterized by anecdotal—as opposed to empirical-based—quantitative analysis, and by limited scope (e.g., study of only the regulations, but not their administration). Similarly, some studies have been carried out by parties with a proprietary interest, or at their behest.

To address these gaps, we conclude with examples for a research agenda, including the following topics:

1. Examine the cost impacts of the more stringent requirements for new construction mandated by the emerging national codes in the areas of seismic provisions, wind impact protection, sprinklers, and plumbing.

2. Examine differences between the various emerging "smart code" regulations affecting building rehabilitation, such as the New Jersey Rehabilitation Subcode and the Nationally Applicable Recommended Rehabilitation Provisions. This analysis should include evaluation in New Jersey, Maryland, and other states of the empirical results (e.g., enhanced renovation activity) from adoption of the smart codes.

3. Analyze potentially lingering onerous building code provisions with respect to rehabilitation. For example, "substantial rehabilitation" may trigger (under governing Federal Emergency

Management Administration [FEMA] and rehabilitation code provisions) expensive new requirements with reference to flood plain and seismic design.

4. Building code research must include cost-benefit study. An example is to use FEMA's Natural Hazard Loss Estimation Methodology to examine the societal consequences of the more stringent seismic and wind provisions, such as cost-per-life-saved. Such research could help define "benchmark" standards and requirements above these benchmarks would constitute "excessive regulations."

5. Another tack for developing a benchmark for appropriate standards is to work backward from the desired "end model" of the affordable housing unit. There is reasonable agreement that the most affordable types of shelter consist of "reinventing" the SRO and allowing accessory housing, such as "granny flats," or other affordable configurations (e.g., Boston "triple decker"). One should analyze how building codes restrict production of these affordable units.

6. More empirical data is needed on the subject, as well as quantitative analysis on how codes affect housing. To illustrate, contemporary information is needed on the local implementation of building regulations, including if a local jurisdiction has a code, the basis of that code, the profile of officials implementing the regulations (e.g., background, education, and civil service status), as well as other details (e.g., prohibited and permitted materials and procedures). The last national comparable survey of that type dates from the late 1960s to the early 1970s, and clearly a contemporary equivalent database is needed. This could be made available via a new survey and/or through tapping extant sources, such as the Building Code Effectiveness Grading Schedule developed by the insurance industry. With such data, we can effect, in a contemporary setting, the quantitative analysis of how building regulations and their administration affect housing.

7. Research on the subject also should analyze the influence of diffusion of innovation. Many extant studies on the impact of codes on housing presume that if a cost-saving material or procedure is available, it will be used—but for code restrictions. The diffusion of innovation literature paints a murkier picture; cost-saving techniques may be resisted because of inefficient information, builder inertia, inadequacy of skills, and perceived rejection by housing consumers, as well as because of code barriers. That murkier reality must be acknowledged in future study on how the building code affects housing.

8. While, as noted, there are many fruitful areas for building code research, overall perspective is needed. In all likelihood, building codes have much less of an impact on new housing costs compared to other regulations, such as zoning and subdivision requirements. As such, building codes constitute a high, but not the highest, priority for regulatory study.

Description of the Regulations/Practices Involved, Their History, Prevalence, and Justifications

Description

The regulation of building construction in the United States is an exercise of government police power, and with very few exceptions (e.g., accessibility for the disabled and manufactured housing), it is legislated at the local or state government levels. It traditionally has been accomplished by means of a set of inter-related codes, each addressing a specific building system or a specific building attribute. While these codes may be packaged in different ways in different jurisdictions, they generally can be described as follows:

- -- A building code that addresses the building's structural system, fire safety, general safety, enclosure, interior environment, and materials.
- -- A plumbing code that addresses the building's potable water supply and waste systems.
- -- A mechanical code that addresses the building's combustion and mechanical equipment.
- -- An electrical code that addresses the installation of electrical wiring and equipment in buildings, and a gas code that does the same with respect to the installation of gas piping and gas-burning equipment.
- -- An energy code that addresses all parts of the building that consume, or contribute to the consumption of, energy.
- -- Other specialty regulations, such as an accessibility code, that addresses building accessibility to the physically disabled.

Because of the technical complexity of these codes and the time and money needed to keep them updated, most state and local governments have abandoned the development and maintenance of their own codes, and rely on adoption (with or without amendment) of a model code (developed by a regional or national association). All of these codes make use of extensive references to voluntary consensus standards on design methods, test methods, materials, and systems. By reference, these standards become part of the building regulatory system. These codes typically are enforced at the local level in a process that begins with the application for a building or construction permit, and followed by plan review, permit issuance, inspections, and certificate of occupancy issuance.

A related but different set of regulations that sometimes are packaged together with the above-described measures are those that control the use and maintenance of existing buildings. Parts of these codes sometimes may overlap with the plumbing, mechanical, or electrical codes, such that some aspects of operation and maintenance are included therein. They generally can be described as follows:

- -- A fire prevention code, sometimes called a fire code, which regulates the building's fire safety throughout its occupancy and use.
- -- A housing code that regulates the health and sanitation of residential buildings throughout their occupancy and use.
- -- A property maintenance code that expands the scope of the housing code to include other types of buildings.

-- A hazard abatement code that identifies building conditions that are so hazardous that immediate remedial action may be required.

These codes are generally enforced at the local level by means of periodic inspections and citation of violations. An existing property that is rehabilitated typically will have to satisfy building, plumbing, mechanical, and sister codes as well as the fire, housing, property, and hazard codes.

A third category of building regulation is referred to as retroactive regulations. These generally address hazards in existing buildings that, while not necessarily imminent, are identified by society as needing remediation. Some examples of such regulation are the enclosure of open stairs in public buildings, the installation of sprinklers, and the reinforcement of unreinforced masonry buildings in zones of high seismicity. Due to the extremely high costs imposed by such regulations on building owners, retroactive regulations are quite rare and local in nature.

While not technically correct, in this paper the term "building code" is broadly used to refer to the entire set of interrelated building-related requirements described above.

Historical Development

The current building regulatory system in the U.S. is the product of several diverse trends. When viewed in a historical perspective, it may be thought of (somewhat allegorically) as resting on four foundations, and as supported by three buttresses. The foundations include the:

-- Insurance industry
-- Tenement and housing movements
-- Engineering profession
-- Construction industry

The buttresses are the:

-- Federal government
-- Model codes groups
-- Voluntary standards organizations

The Insurance Industry. In the 19th century, the insurance industry was the regulator of fire safety in buildings, with an institutional framework created to regulate, as well as to provide research and technical support. For over the past half century, the regulation of fire safety in buildings has been a function of state or local governments, while some of those originally insurance-related organizations continue to perform regulatory support functions to this day: the National Board of Fire Underwriters (today called the American Insurance Association); the National Fire Protection Association (NFPA); and Underwriter Laboratories. The early concerns of these organizations were related to property risk and the risk of conflagration. Concern for life safety became articulated and institutionalized in 1913. It was the National Board of Fire Underwriters that developed and published in 1905 the first model building code in the U.S.: the

National Building Code, which also included housing and structural requirements in addition to fire safety, and continued to be updated and published until 1976.

The insurance industry also was the earliest regulator of electrical safety in building, where the diversity of early local regulations was overcome when many entities came together to create the first *National Electrical Code* in 1897 in a conference that anticipated in some ways today's consensus processes. The *National Electrical Code* has been periodically updated to this day, and has been published exclusively by NFPA since 1965.

Today, in addition to the continued activities of the early organizations, other insurance industry organizations continue to be active in the building regulatory arena. The Institute for Business and Home Safety (IBHS) was created specifically to support the development of regulations in the natural disaster areas of earthquakes, hurricanes, and floods. The Insurance Services Offices (ISO) evaluates building code enforcement programs in states and local jurisdictions throughout the U.S., and provides relative ratings to assist insurance underwriting.

The Tenement and Housing Movements. These movements arose in various U.S. cities toward the end of the 19th century in response to blatantly unhealthy housing conditions. Charitable organizations were established, and many of them joined to form the National Housing Association in 1900 to press for housing reform. Tenement laws developed in American cities in the second half of the 19th century, and in the early years of the 20th century began to reflect these concerns by regulation of health and sanitation, as well as the fire protection aspects of housing. The New York Tenement House Act of 1901 served as a model for many other cities.

Tenement laws also were included in the 1905 *National Building Code*. Since 1939, the American Public Health Association (APHA) has been concerned with housing standards, and usually is credited with development of the prototype for modern housing codes, as well as the health and sanitation requirements in model building codes (including room dimensions and arrangements). In recent years, the latter have been reduced in scope, based on the assumption that they were provided for adequately by the marketplace.

The Engineering Profession. Civil and structural engineering provided the foundation for the structural requirements of building regulations. By the second half of the 19th century, structural analysis and design methods had been developed for various structural materials. These were accepted by a consensus of the profession and were incorporated into early city building codes and the 1905 National Building Code. In more recent years, engineering associations have been involved in developing consensus standards for structural design (American Society of Civil Engineers (ASCE)), mechanical codes and standards (American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and American Society of Mechanical Engineers (ASME)), and plumbing codes and standards (American Society of Plumbing Engineers (ASPE)).

The Construction Industry. The construction industry always has had a vital interest in building regulations, often as a way of furthering—and at other times, limiting—the use of certain materials and construction trades. Perhaps the industry's strongest influence can be seen directly in the plumbing codes, though self-serving provisions can be found in all the codes. Plumbing codes developed early at the local level. The earliest on record is that of Washington, DC, in effect in 1870. Since its organization in 1883, the National Association of Master Plumbers had been concerned with plumbing codes. Nevertheless, extreme diversity reflecting local practices and conditions typified the early plumbing codes.

The National Association of Master Plumbers itself did not publish a model plumbing code until 1933. The National Association of Plumbing-Heating-Cooling Contractors, successor to the National Association of Master Plumbers, has been publishing the *National Standard Plumbing Code*, which is used in many jurisdictions, since the 1970s.

As building codes affect home construction activity and the ability of homeowners and apartment dwellers to secure affordable shelter, understandably the National Association of Home Builders (NAHB) has a long-standing interest in the subject.

The Federal Government. The federal government has played two roles in buttressing the current building regulatory system: provider of technical expertise and formulator of national policies.

As a provider of technical expertise, the National Institute of Standards and Technology (NIST) (formerly the National Bureau of Standards (NBS)), has played a paramount role. Starting with the testing of materials and structural systems in the early part of the 20th century, NIST's role has expanded. Most of the publications of NBS' unique Building and Housing Series from 1921 to 1932 directly addressed the regulatory system (building code organization and format, structural provisions, fire resistance provisions, and a model plumbing code—the "Hoover Code" of 1928). These have had great influence on subsequent modern codes. Since then, NIST has continued to develop technical materials in various areas directly usable by the building regulatory system. Today, NIST provides leadership to, or participation in, multiple voluntary standards activities at the American Society for Testing and Materials (ASTM) International, NFPA, ASHRAE, ASCE, and other voluntary standards organizations that support the regulatory system.

As a formulator of national policies, various federal agencies have often interfaced with building regulations or influenced them directly. Notable in this capacity is the U.S. Department of Housing and Urban Development (HUD), which developed its own *Minimum Property Standards* for underwriting its mortgage insurance programs, and has pressed for the widespread adoption of building and housing codes and code reform, as well as specific provisions. These include accessibility in housing, lead-based paint regulations, and, most recently, codes related to rehabilitation (rehabilitation codes). The Federal Consumer Product Safety Commission (CPSC) has developed safety standards that have been incorporated in building codes (for example, safety glazing). The U.S. Department of Energy (DOE) has been a strong advocate for the development of energy codes. The Federal Emergency Management Agency (FEMA) developed and administers the Federal Flood Insurance Program, many provisions of which have been incorporated in building codes, and FEMA's National Earthquake Hazards Reduction Program (NEHRP) has provided the impetus for current seismic provisions in the building codes. Federal regulations governing manufactured housing are described shortly.

The Model Code Groups. The original three regional model code groups, Building Officials and Code Administrators International (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International (SBCCI), were established as professional associations of building officials and code enforcement personnel (BOCA primarily in the Northeast and Midwest, ICBO primarily in the West, and SBCCI primarily in the Southeast; see figure 1). The impetus for these organizations to enter the code development field, in which they have been predominant for the past 50 years, was provided by the increasing difficulty for state and local governments to develop and maintain technically complex building codes, the recognized need for uniformity in building codes and code enforcement methods, as well as encouragement from industry and government. BOCA was founded in 1915 and published its first model building code, the Basic Building Code, in 1950. ICBO was founded in 1922 and published its first model code, the Uniform Building Code, in 1927. SBCCI followed shortly thereafter, with the publication of the Standard Building Code in 1945.

Until the 1990s, when the three regional groups joined together (described shortly), each of these organizations published and updated comprehensive suites of model building regulations, including building, plumbing, mechanical, housing, fire prevention, and other related requirements. Amendments to the model codes could be proposed annually by anyone with an interest or stake in building design and construction. These amendments would be heard and debated before code change committees, and ultimately would be voted for approval or denial by the membership representing federal, state, and local governments. Supplements to the model codes were published annually, and a revised edition of the model codes was published every three years. These model codes typically would be adopted, with varying degrees of amendment and modification, as regulations by states or local jurisdictions in their respective geographic regions (with some notable exceptions).

The Voluntary Consensus Standards Organizations. Finally, the building regulatory system is buttressed by the voluntary standards consensus process, which develops and updates the numerous standards referenced in every building code. The organizations involved in this process include ASCE, ASTM, ASHRAE, and NFPA, to name but a few. These organizations establish committees to develop and maintain specific standards. Standards can be proposed by anyone with an interest or stake in building design and construction. They are debated in the committees and voted on in a process that attempts to ensure balance among the various stakeholders (e.g., producers, consumers, and general interest).

Recent Developments

A number of changes have typified the building regulatory system in the past few decades.

One- and Two-Family Dwelling Code. In the early 1970s, the three regional model code groups (BOCA, ICBO, and SBCCI) joined with the American Insurance Association (then still the publisher of the fourth model code, the *National Building Code*) to develop a single model code for conventional single-family construction. The code was entitled, *One and Two Family Dwelling Code.* The name was changed to the *CABO One and Two Family Dwelling Code* when the American Insurance Association dropped out, and the three remaining model code groups founded an umbrella organization, the Council of American Building Officials (CABO), the main purpose of which was to maintain and publish this code. The code continued to be published and updated until the establishment of the International Code Council (see below), and evolved directly into the current *International Residential Code* (IRC) published by that group. While the extent of state and local adoption of the *CABO One and Two Family Dwelling Code* throughout the U.S. is not known, it is notable that for the past 30 years, there has existed a single model code applicable throughout the country governing this type of construction.

Regulation of Factory-Produced Housing. The growth of factory-produced housing, whether it be panelized, modular, or manufactured (mobile homes), initiated in the 1970s, has increased in recent years. The production of components or entire houses in a factory, remote from the site of ultimate utilization and often in a different state, and subsequent delivery to the site, requires specialized regulatory procedures. Inspection for code compliance must be done at the factory and certified in a form that can be acceptable at the site. When the factories are located across state lines, the inspection often is to a different code from that in force in the jurisdiction where the factory is located. Procedures and compacts have been developed to accommodate these needs.

Federal regulation has worked to create uniformity of requirements for manufactured housing, thus fostering a national market for this product. In 1976, "mobile homes had come under regulation in the form of pre-emptive federal manufactured Home Construction and Safety Standards, or 'HUD-Code,' and the era of 'manufactured homes' began" (NAHB Research Center (1998: 4)). The Manufactured Housing Improvement Act of 2000 required that the HUD-Code regulation be updated on a timely basis and called on states to implement installation standards and the training and licensing of home installers (Manufactured Housing Research Alliance (2003: 10)). These changes reflected the rising amenity level of manufactured homes (thus prompting the updating of the HUD-Code) and the fact that installation standards had become necessary (since the original HUD-Code did not regulate installation and varying local standards regarding installation had caused problems to the growth of the manufactured home industry).

In the past five years, two trends have been predominant: the emergence of two model codes and the adoption of rehabilitation codes.

The Emergence of Two Model Codes. In the 1990s, the three regional model code groups merged into the International Code Council (ICC) and the ICC began the production a single family of codes: the International, or I-codes. The first complete set of I-codes was promulgated in 2000. Since then, states and local jurisdictions have begun adopting them in place of one of the three (originally four) models previously developed. The process for developing and modifying the I-Codes is much the same as that used by the three regional model code groups. In other words, amendments can be proposed by a variety of interested parties; code change committees and the membership at large then review these proposed changes.

NFPA decided to develop its own building code, NFPA 5000, the first edition of which was created in 2003. The process for developing and modifying this code is the same as that used in the development of voluntary consensus standards. An overview of the current ICC-NFPA regulatory framework, with respect to both new construction and rehabilitation is provided in

Table 1. It should be noted that NFPA 5000 references the ICC *International Residential Code* (IRC) for structural design of one- and two-family dwellings.

Building codes in the U.S. are in the process of shifting from regionally influenced multiple model codes (e.g., BOCA, ICBO, and SBCCI), as is illustrated in Figure 1, to a system influenced by two competing national codes promulgated by the ICC and NFPA (Figure 2). This evolution represents an important change from the system that prevailed for decades.

Thus far, many more jurisdictions have adopted the I-codes. An important exception is California, which has opted for NFPA regulations. There has been an effort by the National Conference of States on Building Codes and Standards, Inc. (NCSBCS) to bring together the ICC and NFPA so that one national code would be brought forth—instead of two competing regulations (NCSBCS (2001)). This integrative effort, thus far, has not proven fruitful, however.

The Adoption of Rehabilitation Codes. Rehabilitation activity in existing buildings has been growing in the past 20 years as a proportion of all construction. Until the 1990s, such work was regulated by reference to the building code (Chapter 34 of the model codes)—the vast bulk of which was addressed to new construction. In the 1990s, it became clear that this form of regulation was often arbitrary, unpredictable, and constrained the reuse of older properties. Beginning with the State of New Jersey, states and local jurisdictions began to develop new ways to regulate work in existing structures, using what came to be known as rehabilitation codes, and in some jurisdictions as smart codes. New Jersey adopted its rehabilitation code in January 1998. In May 1997, HUD published the Nationally Applicable Recommended Rehabilitation Provisions (NARRP) to serve as a model for the development of rehabilitation codes. Since then, smart codes have been adopted by several states and local jurisdictions, including Maryland; New York State; Rhode Island; Minnesota; Wilmington, Delaware; and Wichita, Kansas. In 2003, the International Existing Building Code (IEBC) was added to the family of I-codes, and the NFPA 5000 code developed a rehabilitation code as its Chapter 15 (see Table 1). The extent of local adoption of these model rehabilitation codes is unknown at this time. These new codes are based on two principles. The first is predictability, namely that clear rehabilitation code regulations would foster the accurate prediction of improvement standards and costs. The second principle is that of proportionality, in that a sliding scale of requirements is established depending on the level and scope of the rehabilitation activity, from repairs to reconstruction. The overall goal of the rehabilitation codes is to encourage the reuse of older buildings. The different rehabilitation codes are considered in detail later in this paper.

Prevalence and Framework of Building Codes

In 1968, the National Commission on Urban Problems (1968: 256) conducted a national survey of all local governments in the U.S. and found that about half (46.4 percent) had a building code. Comparable national data is not available today, but by all accounts, the share of local jurisdictions with building codes has increased, especially among larger local jurisdictions and those in metropolitan, as opposed to rural, areas. In fact, a survey dating back to the 1970s that focused on cities with more than 10,000 in population, found almost all (96.7 percent) used building codes (Field and Ventre (1971: 139)).

According to the NCSBCS "over 90 percent of the [U.S.] population live, work, and recreate in one of the 44,000 jurisdictions in the U.S. with a building code . . . These codes govern over $1.1 trillion a year in the domestic construction industry, accounting for 12 percent of the gross domestic product in the U.S" (NCSBCS (2004: 3)).

While most code provisions are enforced locally, their technical basis is increasingly framed to some measure by the state. As of the mid 1970s, 22 states had a state building code. Of that total, 15 had a state building code governing single-family housing, while 19 had the same with respect to multi-family housing (Office of Building Standards and Code Services (1975)). As of 2003, according to data provided to the authors by NCSBCS, 46 states had a state building code[i], and of those, 28 such regulations governed single-family housing and 37 regulated multi-family housing. Of the 46 states with state building codes; nine state codes applied only to government-owned buildings, thus leaving 35 state codes applying to privately owned properties. (The preceding discussion may oversimplify the complexities among the states.)

For the most part, these statewide codes were based on one of the three model codes, and now, to a growing extent, the ICC codes. That system seemingly would mean that numerous states in different regions of the country had uniform model-code-based regulations that would have to be followed at the local level. In fact, the regulatory system is far more disparate.

First, many states that based their state building codes on one of the models incorporated exceptions or amendments of their own, or did not continuously incorporate the latest versions of the model codes. (As of 2003, that was the case of 24 of the 46 states with state building codes.)

Second, many state building codes applied only to certain categories of property, such as noted, only public buildings, or exclusively multi-family dwellings.

Third, even when the state building code applied to all or most properties, the regulation usually was not absolutely binding on local jurisdictions. Many state building codes (13 of the 46 in 2003) established only *minimum standards*. Local governments were allowed to add to these base standards, thus potentially making the local codes more stringent (22 states; see Table 2), or if not more stringent, then simply altered from the base state-level requirements. Such local modification might require state approval or some other procedure (e.g., the locality having to document the case for the modification); however, these requirements were not very demanding so that local modifications were common. Only a small minority of states with state building codes, including Connecticut, Kentucky, and New Jersey, framed their state building code as a *maximum* from which localities could not deviate. With the exception of this minority of states, and even among these states for properties not covered by the state building code, local jurisdictions routinely tinker with their building regulations. The net result is that with few exceptions (e.g., Connecticut and New Jersey) different communities within a state often impose different building code requirements.

Justification of Building Code Provisions

The model codes have traditionally stipulated health, safety, and welfare of building occupants and society as the objectives of building regulation. To illustrate, paragraph 101.3 of the IBC 2003 states:

> "**101.3 Intent.** The purpose of this code is to establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment and to provide safety to fire fighter and emergency responders during emergency operations."

The corresponding paragraph R101.3 of the IRC, in addition to other minor differences, adds "affordability" to the list of means of achieving the intent.

Theoretically, various benefits accrue from building regulations. According to Oster and Quigley (1976), these benefits include "protecting the consumer from the consequences of their own ignorance" (e.g., a homebuyer purchasing a hazardous dwelling), as well as external benefits, such as protecting surrounding properties, or the community at large, from a dwelling that could collapse, catch fire, and otherwise be hazardous. Admittedly, there are ways other than regulation to achieve some of these benefits, such as having potential housing consumers draw upon professional inspectors so as to avoid unsafe dwellings. Another way is to have property owners carry insurance against external dangers threatening the community at large, but that private-based system, however, is surely not foolproof, for inevitably some consumers would not avail themselves of professional services and insurance. Hence, many, but surely not all (Colwell and Kau (1982)), accept the rationale of benefits accruing from building codes that argue for their promulgation.

The benefit of realizing the various building code objectives are presumed to justify the costs imposed on building owners, occupants, and society at large. The debates about specific changes to the regulations, be they in the voluntary standards arena, the model code arena, or the adopting jurisdiction, are usually couched in terms of this stated intent. Even the most blatant attempts to preserve or enhance proprietary market share are so couched. In fact, however, rarely is one presented with a benefit/cost analysis to justify proposed regulations or to change the regulatory status quo—a deficiency discussed later in this paper.

Theoretical Description of the Ways That Building Codes Could Affect Housing

As is indicated in Figure 3, the idealized goal for building codes (or, for that matter, any regulation) is to incorporate substantive regulations that are "appropriate" and to administer these regulations in an "appropriate" fashion. Deviation from this goal adversely will add to housing costs. The greater the deviation, the greater the excess housing cost.

This paper's model, of course, begs the question of what is "appropriate." In a general sense, an appropriate building code would be one that adheres to the objectives described earlier, namely protecting the housing consumer and society at large in a balanced cost-benefit fashion. That, too, however, begs the question of specifics.

We can begin to frame in a more specific way what might be inappropriate building codes from both a substantive (technical) and administrative perspective.

I. Substantive Impediments

a. Require questionable improvements
b. Restrict cost-saving materials and technologies
c. Impede scale and efficient production
d. Other challenges

II. Administrative Impediments

a. Skill inadequacies
b. Administrative conflicts
c. Administrative delays
d. Excessive fees
e. Other challenges

These admittedly interrelated characteristics are described and illustrated below.

Substantive Impediments

Require Questionable Improvements. A classic example is the "25-50 percent rule" governing rehabilitation. This rule mandated that if investment in a building exceeded a certain threshold, then the entire building would have to meet the standards for new construction, not just the area being worked on. This rule was perverse on a number of counts. First, it discouraged needed investment in existing buildings, so as to avoid the 25-50 percent trigger. Second, it mandated a new construction standard for rehabilitation, which was frequently technically problematic, expensive, and unnecessary. For instance, a non-profit group doing affordable housing rehabilitation in New Jersey was forced by the 25-50 percent rule to widen a stairway that was 3/4" too narrow and to replace windows that were 5/8" too small. The existing stairway and windows were perfectly serviceable and had been in place for almost a century, yet had to be replaced, at a cost of thousands of dollars, to meet the new building standard (Listokin and Listokin (2001: 89)).

A current example, it might be argued, are the most recent requirements for seismic design in new construction in some parts of the country. As a direct result of FEMA efforts under the National Earthquake Hazards Reduction Program (NEHRP), seismic design is now required in regions of the country that ignored this until recently. While regions of differing seismicity are recognized, it is reported that the requirement applicable in Maryland, when building on certain types of soil, may preclude the use of flat plate concrete construction—commonly used for many years in multi-family housing construction. While the seismic design improvements are based on extensive and thorough analysis over a long period of time (probably more than most other code changes), and while FEMA will strongly support them, others may find them questionable as to reasonableness and cost.

There are other instances of questionable requirements. Four-story, combustible buildings in New York City are cost efficient for both housing and commerce (and mixed uses), are permitted as Type III construction under the IBC, and, in fact, were once quite typical in this urban area. Despite these advantages and history, the current New York City code prohibits such structures (Schill (2004)).

Restrict Cost-Saving Materials and Technologies. While residential construction may be a relatively "low tech" industry, constant advances have been made with respect to cost-saving materials and technologies. In the 1960s and 1970s, these included, as examples, the use of plastic pipe, preassembled plumbing, and prefabricated metal chimneys, as well as the installation of bathroom ducts instead of windows (National Commission on Urban Problems (1968: 258)).

Current cost-saving examples include use of pre-cast foundation walls, wood/plastic composite exterior trim/molding, fiber cement exterior trim materials, and laminate flooring (Koebel (2003: 15)). Despite their potential cost savings, all of the above-listed innovative materials and procedures were at one time prohibited by some local building codes. To a certain extent, this may have been due to the building code approval process simply lagging the leading edge of technology and innovation. Yet, more questionable self-interest influences sometimes played a role, such as plumbers trying to control the market and limit competition by intentionally resisting the use of plastic pipe (because it was easier and less costly to install, thus reducing plumber chargers).

On the other hand, some would argue that recent cost-saving systems, such as Exterior Insulation and Finish Systems (EIFS), were prematurely accepted by local codes, leading to failures and legal actions.

Impede Scale and Efficient Production. The multiplicity of codes can discourage the entry of builders and material suppliers, inhibit mass production, and increase professional costs. Notes one observer (Field and Ventre (1971: 147)).

> Analysts and critics of the housing industry have pointed to the deleterious effects of code fragmentation upon producer efficiency and upon the introduction of new technologies. Development of new technologies and methods of construction is a costly process. Hence, the producer must sell to a large market before he can bring costs down to a level that will represent saving over the traditional construction approaches. Achievement of a large market requires selling in many different communities. But if these communities set different construction standards, they destroy the cost savings implicit in large volume production.

Manufactured housing is illustrative. These units provide an opportunity for affordable housing; a 2,000-square-foot manufactured home costs only 61 percent as much as a comparable site-built home (Apgar, Calder, Collins, and Duda (2002: 2)). A major reason for this savings is economy of scale. In the late 1990s, the two largest manufactured home producers each built 60,000 homes (NAHB Research Center, Inc. (1998: 5)). Such production would not have been possible were these producers confronted by different building code standards for manufactured homes in different states and localities—the situation that existed before the HUD-Code was promulgated in 1974. In this pre HUD-Code era, local codes, indeed, were a major obstacle. A late 1960s survey of 242 home manufacturers revealed that diverse local building codes was their primary obstacle (National Commission on Urban Problems (1968)).

While manufactured housing is a classic example of how scale and efficient construction can be thwarted by multiple building codes, conventional construction also can be affected. For instance, multiple building regulations and other code characteristics, such as arcane code language, can increase the learning curve for builders and professionals (e.g., architects) to familiarize themselves with the building regulations governing a given area. This, in turn, may very well limit competition among developers and professionals working in a given location, and, thus, may increase construction costs. While this so called "cartel effect" is mentioned in the literature, it has not been empirically examined.

Other Challenges. Numerous other substantive requirements could add to costs. Added technical requirements can increase professional expenses. For instance, single-family, or small multi-family, construction typically does not require advanced engineering analyses, which can be costly. Yet that situation can change if the building code imposes seismic protection safeguards, mandates sprinklers, and/or raises snow load requirements.

A poorly written and disorganized building code also can raise expenses because it will take more professional time to comprehend and use the regulations. Arcane and poorly organized text also increases the likelihood of uneven interpretation by inspectors, one of numerous administrative impediments discussed below.

Administrative Impediments

Another paper in this conference is considering administrative barriers; therefore, only an overview of potential administrative challenges related to the building code is given here.

Skill Inadequacies. Code personnel may not be adequately trained for their often technically demanding jobs. That, and insufficient experience, may foster inconsistent interpretation. Inadequate preparation and experience, and a fear of liability, may make inspectors "go by the book" instead of properly granting variations where warranted.

Administrative Conflicts. Compounding the problem is the potential for administrative conflicts. The field versus back-office staff of the same code-administering unit may not see eye to eye. The potential for disagreement is even greater between staff of different departments charged with code oversight, such as building versus fire departments.

Administrative Delays. Code administrative delays can add to costs. It may take far too long to "pull a permit," schedule an inspection, or have a variation request reviewed. The threat of a stop-work order prompted by a code disagreement is chilling because it can halt construction in its tracks. Delays also may ensue if the building code requirements are not well coordinated with other regulations (e.g., zoning and environmental) imposed on the residential development industry.

Excessive Fees. Excessive fees can unnecessarily add to costs. Theoretically, the building code fees should merely recover outlays for code review, inspection, and other services. In fact, local units of government may impose high building code fees as a separate profit center.

Other Challenges. Corruption may further becloud building code administration. Sadly, bribery is a recurring scourge in building code enforcement, and that both adds to costs and saps the integrity of the system.

Summary of Theoretical Impacts

The numerous building code substantive and administrative challenges described above can frustrate residential development and add to housing costs. It is assumed that most of the added expenses from the adverse requirements and poor administration will be passed along to the housing consumer, as opposed to being absorbed by the producer.

The above constitute the direct impacts of building codes on housing. There can be further indirect and simultaneous consequences. As argued by Noam (1982: 395, 396), if building codes increase the cost of new housing, then it stands to reason that codes may very well lead to a rise in price of existing housing (because of the positive cross-elasticity of demand between new and existing housing).

There also may be a simultaneous effect in the sense that building codes may increase housing prices, and areas with the highest housing prices may very well opt for the most restrictive codes in order to maintain their cachet and to exclude the poor. As discussed shortly, this simultaneous influence of building codes is examined by Noam (1982) and is noted in a different context (zoning and land costs) by Glaeser and Gyourko (2003).[ii]

Many aspects of the above theoretical description of the ways in which building codes affect housing are discussed in the extant literature on the subject.

Summary of the Literature

The section below overviews studies on the impact of building codes on housing production and costs, focusing first on analyses considering the codes' influence on new housing construction, and then on reports examining the building code impact on rehabilitation. Following this overview, the extant literature is critically examined.

Literature on Building Codes and New Construction

For an overview of some of the earliest studies on this topic, Oster and Quigley (1976: 364) is quoted:

> Maisel's early study (1953) of the San Francisco housing market concluded that an increase of less than one percent in the cost of newly constructed housing was attributable

> to “known code inefficiencies” (pp. 249-250). Muth’s 1968 econometric analysis of single, detached housing suggested that locally modified building codes increased average cost by about two percent (as reported in Stockfrisch). (1968: 8)

The National Commission on Urban Problems (1968; often referred to as the Douglas Commission) conducted one of the most comprehensive building code studies of all time. It found that unnecessary housing costs are inherent in building codes that delay construction, prevent the use of modern materials, mandate antiquated and outdated provisions, inhibit mass production (e.g., the marketing of mobile homes), prevent large-scale conventional construction, and are questionably administered.

The Douglas Commission’s findings were based on testimony before its members and empirical study by its consultants. The latter included a national survey of code implementation and code requirements. It found that many communities, even those nominally adhering to model codes, prohibited cost-saving materials and technologies (e.g., use of plastic pipe and preassembled plumbing units) that, generally, were allowed by the model codes. These communities added prohibitions of their own, or did not adopt the latest version of the model codes, etc. The Commission analyzed that these excessive requirements—over and above the model code and other benchmarks, such as the standards contained within the Federal Housing Administration’s (FHA’s) Minimum Property Standards—could potentially add $1,838, or 13 percent, to the price of a basic home (then estimated at $12,000).

Field and Ventre (1970) surveyed building codes in 1,100 communities in the U.S., including their administration. This work was done for the International City Management Association (ICMA). Field and Ventre developed a local building code “prohibition score” related to if a city prohibited 14 construction materials and procedures earlier identified by the Douglass Commission as innovative (and usually allowed by the model codes). On the plus side, Field and Ventre found a decline in the share of jurisdictions prohibiting innovations since the Douglass Commission survey. Nonetheless, many communities surveyed by Field and Ventre, even those nominally under an enlightened model code framework, still resisted cost savings materials and procedures—thus echoing the Douglass Commission’s findings cited earlier. Field and Ventre concluded that the building code had a “disastrous impact . . . on the efficiency of the construction industry” (Field and Ventre (1970: 139)).

Muth and Wetzler (1976) examined the effects of four constraints on housing costs: (1) union restrictions; (2) building supplier restrictions; (3) small size of building firms; and (4) restrictive building codes. The authors measured the restrictiveness of the building code by such factors as the codes’ substantive basis (the authors assumed that construction costs would be less expensive in jurisdictions nominally governed by a model code), as well as the codes’ timeliness (the authors assumed that more recently adopted building codes would more likely allow cost savings).

Muth and Wetzler studied, via multiple regression analysis, the relationship of the price of new single-family houses to the characteristics of these houses (e.g., number of bedrooms and baths) and measures of the four constraints. The authors found that the constraints, overall, had only a minor effect on the cost of one-family housing. With respect to the building code, Muth and Wetzler concluded “the effects of local building code on housing cost is, at most, small. Local building codes probably add no more than two percent, while the impact of unions on construction worker wages would appear to increase housing costs by only about 4 percent" (Muth and Wetzler (1976: 57).

Seidel (1978) analyzed the extent to which seven types of government regulations, including building codes, added to housing costs. For a $50,000 single-family home (as an example), excess costs from government regulations were said by the author to amount to $9,844, or about 20 percent, comprised as follows:

Development stage [iii]	$5,115
Construction stage [iv]	$4,129
Occupancy stage [v]	$600
Total	$9,844

Of that total, excessive costs related to restrictive building codes were estimated at about $1,000, or roughly one percent of the $50,000 house cost. (These were all hypothetical "worst-case scenarios.") Seidel's study of the building code contribution to excessive cost included a survey of if localities prohibited innovations typically allowed by model codes (e.g., plastic pipe) or required "nice but not necessary" provisions (e.g., ground fault interrupters). Thus, his work paralleled earlier research done by the Douglass Commission (1968) and Field and Ventre (1970). As previous researchers, Seidel found that even jurisdictions nominally following national or state building codes often had excessive standards.

Noam (1982) tapped the Field and Ventre prohibitions score information (i.e., the degree to which 14 innovative construction materials and procedures were disallowed), and then weighted these prohibitions by their relative costliness to builders in order to construct an "index of restrictiveness" (398). Noam developed a model (1983: 397) where the value (*V*) of housing is a function of the restrictiveness of its local building codes:

$$V = f(R_1 X_1)$$

Where R_1 is a continuous variable measuring strictness (i.e., the index of restrictiveness) and X_1 is a vector of other factors that contribute to housing price, such as median household income and population increase. Noam further hypothesized that higher income areas might likely adopt more restrictive codes in order to keep housing prices high and to exclude the poor. In other words, there might be a simultaneous relationship between housing prices and a restrictive building code.

Using multiple regression, Noam applied the described model in the 1,100 communities originally surveyed by Field and Ventre and found that restrictive codes raised housing values.

> If we define a strict code as one with all 14 code restrictions in place, and compare it with the mean strictness of codes prevailing nationwide, R = 4.37, the difference in housing prices is V = $1,060, *certis paribus*. This figure is not insignificant, comprising as it does a percentage of 4.90 in housing values over the national mean. (Noam (1983: 399))

Noam also found that the strictness of codes is, in turn, affected by housing values (i.e., areas with high-priced housing are more likely to adopt restrictive housing codes, thus maintaining their exclusiveness), as well as by the strength of unions (i.e., areas with strong, organized labor unions are more likely to have stricter codes).

Contemporary with Noam's research was the release of a report by the President's Commission on Housing (1982). It noted that (216-217):

> Building codes were created to provide special protection for . . . health and safety. Over the years, state and local governments have tended to add extra elements of protection. . . State and local governments have not acted uniformly, thereby creating differences not only among states, but also among adjoining communities. . . . A further problem is that enforcement and interpretation of identical code requirements vary greatly from community to community. . . . Estimates of the cost of all unwarranted variations range from 1.5 percent to 8 percent of the selling price of the average house.

A decade later, another housing commission considered the impact of building codes and other housing regulations on housing cost and development (Advisory Commission on Regulatory Barriers (1991)) and reported that (3-6):

> Since the early 1900s . . . significant steps have been taken in the development of uniform standards. But code problems continue. Major problem areas include antiquated codes, poor administration, and duplicate regulations.
>
> Building and housing codes often represent major barriers in housing affordability. . . . Not only can codes raise costs within a given jurisdiction, but differences among jurisdictions within a metropolitan area can also create frustrating problems for architects and builders.

The Commission's study (so-called "NIMBY report"—meaning "Not in My Backyard") did not put a price tag on the many regulatory barriers to affordable housing. However, one of its prominent members later suggested that the cumulative cost increase (from building codes and many other barriers) could be as high as 50 percent (Downs (1991: 1098)).

The NIMBY report evoked considerable interest in regulatory barriers. The Consolidated Plans[vi] of numerous states (e.g., Colorado, Maryland, Montana, Oregon, and Texas) cite building codes as a governmental constraint to affordable housing. These references tend to be of an anecdotal and undocumented manner, as is illustrated in the Montana Consolidated Plan:

> In recent years the cost of new home construction in Montana has greatly outstripped personal income growth. The result has been a rapid creation of a housing affordability crisis. . . . One potential element of these cost factors is the uniform building code standards adopted by the Montana Department of Commerce. (State of Montana (2000: 56))

The impact of building codes has been considered in much greater depth in a series of state and some local community case-study reports on housing costs and regulatory barriers in Colorado (Colorado Department of Community Affairs (1998)), Minnesota, (Minnesota Office of the

Legislative Auditor (2001)), Massachusetts (State of Massachusetts (2000 and 2002)), New York City (Salama, Schill and Stark (2001)), and Boston (Euchner and Frieze (2003)). The Minnesota study, for example, surveyed 1,106 developers, builders, and local housing organizations on impediments to housing construction. While the cost of land, labor, and materials—particularly land—was most often cited as a "significant limitation," code constraints were also noted.[vii] Minnesota building code issues included alleged "excessive" requirements (e.g., regarding energy conservation and sprinklers in certain apartment buildings), administrative issues (e.g., inconsistent local interpretation), and fees in excess of the costs to administer the codes (Minnesota Office of the Legislative Auditor (2001, 40-44)). Excerpts from sister state and local studies regarding building codes and new housing construction are reported in Table 3.

Literature on Building Codes and Rehabilitation

Numerous of the investigations cited in the preceding section regarding new construction considered, as well, code impacts on rehabilitation.

The National Commission on Urban Problems (1968) criticized new-construction-based building code standards as being unsuitable for housing renovation. In 1977 and 1978, Metz concluded that building codes, premised on new building standards, were a hindrance to renovation. These themes were repeated in the National Bureau of Standards (1979) report entitled, *Impact of Building Regulations on Rehabilitation—Status and Technical Needs*, which focused on the ways in which building codes hampered renovation, such as requiring unreasonable new-construction-level improvements. The President's Commission on Housing (1982) similarly pointed to the additional costs imposed by strict building codes in the renovation of older units and the dampening effect of the codes on innovation. Other reports focused on similar issues: Building Technology, Inc. (1981a, 1981b, 1981c, 1982, 1987); Ferrera (1988); Ferro (1993); Holmes (1977); Kaplan (1988); Kapsch (1979); and Shoshkes (1991). In response to the identified building code problems, HUD released model *Rehabilitation Guidelines* in the early 1980s (National Institute of Building Sciences (1981a, 1981b, 1981c)).[viii]

Some of the impetus for housing rehabilitation stems from growing appreciation of historically preserved older neighborhoods, and many studies have pointed out the difficulty of satisfying new-construction-based building codes in effecting historic renovation. In 1988, a report to the West Virginia Task Force for Historic Preservation Legislation (Harper, Hydier, and Hopkins (1988)) recommended greater flexibility in building code requirements, since the requirements often make rehabilitation more expensive than demolition and new construction. A 1989 report entitled, *Building Codes and Historic Preservation* (Coleman (1989)), identified the following code-related impediments to rehabilitation: strict egress requirements, lack of fire ratings for existing materials, overly strict code officials, extensive approval time, and officials unaware of code provisions.

Hearings before the Advisory Commission on Regulatory Barriers to Affordable Housing (1990a, 1990b) noted many barriers to rehabilitation, including the use of prescriptive, rather than performance-based, building codes; building inspectors who were overly strict in enforcing the building code because they were fearful of liability; and building code restrictions (e.g., 25-

50 percent rule) that increased construction costs. The commission's report concluded that (Advisory Commissions on Regulatory Barriers (1991: 6)):

> Chief among the urban regulatory barriers are building codes geared to new construction rather than to the rehabilitation of existing buildings. The codes often require state-of-the-art materials and methods that are inconsistent with those originally used. For example, introducing newer technologies sometime requires the wholesale replacement of plumbing and electrical systems that are still serviceable.

The post-NIMBY report era of studies on regulatory barriers often involved some references to building code barriers to rehabilitation. The Maryland Consolidated Plan (State of Maryland (2000)) cited building codes as an impediment to rehabilitation because they conflict, overlap, and vary from jurisdiction to jurisdiction—a sentiment echoed in the Consolidated Plans of Connecticut (2001); Colorado (2000); Massachusetts (2002); and the cities of Tampa, Florida (1998); Knoxville, Tennessee (2000); and San Antonio, Texas (2000). The detailed state case studies considering regulatory barriers, cited in the previous section on new construction, also often considered the building codes' impact on rehabilitation. For example, the Massachusetts rehabilitation building code, once considered a national model, was now deemed as a "barrier" (Euchner and Frieze (2003: vii)) because of conflict in administration between fire, building, and other departments (20-21); and added requirements related to seismic and sprinklers (23-25).

The administrative code conflicts of Massachusetts were not unique. *A National Survey of Rehabilitation Enforcement Practices* contacted 223 code officials and found that more than 80 percent reported code review by two or more city agencies that often failed to communicate during the approval process (University of Illinois 1998, xviii). This survey also found lingering field-level application of the 25-50 percent rule and "change-of-use rules,"—despite the fact that the model codes had done away with or significantly moderated these archaic principles.

As noted, the 1990s witnessed efforts to adopt "smart codes," and related to that were supporting studies showing how traditional, or "unsmart," building codes could add to costs. A number of case studies in Trenton, New Jersey, found that questionable code administration and unreasonable improvements required before New Jersey adopted its smart code added thousands of dollars in cost and months of delay (Listokin (1995)). New Jersey ultimately adopted a smart code in 1998, and various initial estimates were made on the impact of this change. The New Jersey Division of Codes and Standards estimated that its smart code shaved between 10 and 40 percent from the cost of building renovation (Fisher (2001: 15)). There was a spurt of rehabilitation activity in New Jersey, from $176 million in 1996 and $179 million in 1997 to $287 million in 1999, and part of that increase was attributed to the code reform and the potential savings it allowed (Forest (1999)). Illustrative was the rehabilitation and adaptive reuse of a building in Jersey City that cost $1,145,000 under the new smart code, or 25 percent less than the $1,536,222 it would have cost under the former New Jersey code (Forest (1999)).

There was a genre of similar studies. The NAHB Research Center (1999) compared the material and labor costs of an illustrative New Jersey rehabilitation project before and after the smart code. The NAHB report concluded, "the total cost of the project under the old code could have come in as much as 20 percent over the total project cost" (NAHB Research Center, Inc. (1999: 20)). A Michigan State University Study claimed that New Jersey's new rehabilitation code decreased rehabilitation costs in the state by 25 percent and increased rehabilitation activity by approximately 25 percent (Syal, Shay and Supanich-Goldner (2001)).

The most comprehensive study on the impact of smart codes is currently being conducted at the University of North Carolina at Chapel Hill for the Fannie Mae Foundation (Burby, Salvesen, and Creed (2003)). This analysis considers rehabilitation activity and investment in New Jersey and other jurisdictions, and statistically examines the effect of smart codes reform, as well as "facilitative" code enforcement (i.e., flexible/reasonable application of regulations). This detailed analysis has not yet been released, but the overall conclusions are that smart code reform and facilitative code enforcement both have a moderate effect in promoting rehabilitation activity.

Purported Building Code Impact on Housing Costs

Our review of 50 years of literature on this subject is admittedly cursory. We have, for instance, not cited numerous brief, anecdotal reports of how building codes supposedly influence housing costs. Illustrative is an interview conducted by Babcock and Bosselman (1973: 14) of a builder claiming that building codes increased housing costs in Ohio by as much as 250 percent. Another example is a *Chicago Tribune* article (based on a developer interview) that attributed a 20-percent increase in housing costs in Chicago to "old-fashioned, expensive material and outdated construction methods kept in Chicago's Code" ("Building Codes" (1999)).

While admittedly disparate in type and quantitative rigor (discussed shortly), the literature on the subject of building codes and new housing costs has claimed that codes increase the cost of new housing from roughly one percent to over 200 percent. The more quantitative studies such as Maisel (1953), Muth and Wetzler (1976), and Noam (1982) are at the lower end of this spectrum, and find code-related housing cost increases of five percent or less.

Only a few reports have attempted to quantify the building code impact concerning the rehabilitation of existing housing. Focusing on the potential savings of smart codes as opposed to traditional regulations, these reports indicate, at the high end, a savings of about 20 to 40 percent (Syal, Shay, and Supanich-Goldner (2001); NAHB Research Center, Inc. (1999); Forest (1999); Fisher (1999)) to a much lower "moderate effect" (Burby, Salvesen and Creed (2003)).

Since some of the above-cited literature examined the impact of an array of regulations on housing cost, we can report on the relative effect of building codes vis a vis other requirements. As noted, Seidel (1968) found that all excessive regulations added about $10,000 to the cost of a $50,000 home. Of that $10,000, restrictive building code requirements added about $1,000, compared to a roughly $5,000 premium exacted by excessive zoning and subdivision requirements. Thus, the building code added to expenses, but not to the same degree as land use and improvement requirements. In a similar vein, the Minnesota survey of ranking of impediments to single-family housing placed the building code as a barrier that was less challenging relative to zoning and impact fee requirements (Minnesota Office of the Legislative Auditor (2001: 27-28)).

Analysis of and Gaps in the Literature

In analyzing the literature, it is reasonable to consider such characteristics as its *timeliness*, *conceptual basis*, *methodology*, and *scope*.

Timeliness refers to how current the literature is. As earlier described, building codes in the U.S. are a moving target. Thirty years ago, a minority of the states had a state building code governing all, or certain, categories of construction, and these codes were typically based on one of the regional model codes (e.g., BOCA, ICBO, or SBCCI). Over time, a majority of the states opted for the above-described strategy. Most recently, the regional codes have typically been dropped in favor of the ICC or NFPA model codes.

Ideally, the literature would focus on the contemporary situation. In fact, the opposite is the case. The vast majority of the most empirical and statistically rigorous studies, such as the National Commission on Urban Problems (1968), Field and Ventre (1971), and Noam (1982), are based on the code world of two generations back. While we can still learn from this literature in terms of conceptual framework and methodology, their findings, based on the code world of yesteryear, are inherently archaic.

The most contemporary of the literature concerns the adoption of the rehabilitation codes and includes studies by Burby, Salvesen, and Creed (2003); NAHB Research Center (1999); Listokin and Listokin (2001); and Forest (1999). However, the rehabilitation code is only one component of the larger subject of building codes and housing costs, and in this larger dimension, and specifically considering how codes affect new construction, there is a paucity of current research.

A second dimension for considering the literature on building and housing costs is the studies' *conceptual basis*. Discourse in this topic must fundamentally address what is the benchmark standard of code regulation and administration (the upper left box of Figure 3), above which regulation is considered inappropriate and, therefore, contributing to excess housing costs. In developing this benchmark standard, which goes to the heart of the justification for the building code, an analysis of both the costs of various potential building code regulations, as well as the benefits ensuing from these regulations, ideally would be conducted.

How does the literature fare in developing the benchmark standard and similarly, conducting cost benefit analyses? For the most part, the literature gets a middling grade on the first count and fails on the second.

How is the baseline standard determined in the literature (see Table 4)? Numerous studies do not consider this issue (Babcock and Bosselman (1973); "Building Codes" (1989)) or implicitly refer back to one of the model codes as the standard against which local building code requirements should be judged (Presidents Commission (1982), Advisory Commission (1991)). Other studies explicitly refer to the model codes as their baseline (Muth and Wetzler (1976)), or develop a list of building innovations, which themselves are often model code-based, for testing as to their acceptance at the local level (National Commission on Urban Problems (1968); Field and Ventre (1971); Siedel (1978); and Noam (1982)).

Given the comprehensive consensus basis through which model codes are adopted, let alone the technical expertise and experience of the entities participating in the model code development process, it is reasonable to turn to the model codes as a benchmark. As Muth and Wetzler (1976, 60) argue, “construction should be less expensive under less restrictive building codes (presumably under any of the four “national” codes).” This thinking underlies HUD’s denoting local adoption of a current version of one of the model codes as a “marker” for effective local regulatory reform (Federal Register 2003: 66291).[ix]

But others take a less sanguine view. Colwell and Kau (1982) consider the model codes as anything but model and take a particularly dim view of the extant code enterprise (1982: 77):

> Codes have been subverted by special interest groups in and out of government to accomplish a number of purposes, from selling more lumber to reducing the liability of code officials. In fact, there is no body of evidence that shows that building codes add to health and safety in any way.

Our point is not to endorse the position of Colwell and Kau, but rather to raise the issue that using the model codes as a benchmark (or “marker”) is far from bulletproof.

There also are issues in developing a building code benchmark from a list of innovative practices or perceived excessive requirements. This list is subject to changing priorities and perspectives. For example, Seidel (1978: 85) included smoke detectors in homes as an excessive building code requirement. Would a smoke alarm be so viewed today?

In an ideal world, deliberation of what comprises the building code benchmark would consist of review of requirements, which inevitably have costs, analyzed against their benefits. In other words, to do a cost-benefit analysis.

There is some study on this subject. A 1978 report by NBS (McConnaughey (1978)) suggested an evaluation approach for considering the costs versus benefits of building code standards, and illustrated this approach by analyzing the implications for ground fault circuit interrupters (GFCIs) in residences. This report estimated how much it costs society to save a life through the GFCI provision and found this cost to range (depending on the assumptions) from $2.5 million to $4 million.

Hammit, Belsky, Levy and Graham (1999) conducted a more recent investigation considering cost-benefit implications with respect to codes. This study found that building codes that increase housing costs have societal implications from “income effects” (i.e., households that purchase a new home have less income remaining for spending on other goods that contribute to health and safety) and “stock effects” (i.e., suppression of new-home construction leads to slower replacement of less safe housing units). The study estimated that a code change that increases the nationwide cost of constructing and maintaining homes by a small measure (the study considered, as an example, a $150 expense, or 0.1 percent of the average cost to build a single-family home) would induce from the income and stock effects offsetting risks yielding between two and 60 premature fatalities or, including morbidity effects, between 20 and 800 lost quality-adjusted life years (Hammit, Belsky, Levy and Graham (1999: 2)).

The two studies cited above illustrate the type of cost-benefit analysis that would inform determination of the benchmark for building code requirements. One would further have to determine if, say, the GFCI cost-benefit of roughly $3 million per life saved warranted the universal requirement of GFCIs. Having the cost-benefit data is crucial, however, for determining the appropriateness of requirements. Yet, as was discussed earlier, and as we can see from Table 4, cost-benefit analysis is rarely conducted.

A third dimension for considering the literature on building codes and housing costs concerns *methodology*. The latter can include various qualitative approaches, such as gathering testimony from builders and other informed parties (an anecdotal, impressionistic approach) or conducting focused, in-depth case studies related to the building code (e.g., the rehabilitation situation in New Jersey before and after its smart code). The methodology also might include more quantitative-oriented information gathering and data analysis. One example is structured surveys of builders or building inspectors. Another is statistical analysis drawing upon the survey data or considering other subjects (e.g., are local restrictions significantly linked with higher local housing costs?).

While all these methods inform the analysis of the association between building codes and housing costs, ideally the more rigorous quantitative study would be emphasized. In fact, the opposite is the case, as is evidenced from Table 4. Much of the literature, including some of the most widely quoted reports such as the NIMBY study, rely on qualitative and often anecdotal evidence (Hartman (1991: 1163)). In fact, there are only a handful of statistical regression analyses of how housing codes affect costs (Muth and Wetzler (1976); Noam (1982)) and these studies, as noted, are now quite dated. This situation stands in marked contrast with other regulatory barriers such as zoning and impact fees, where much more statistical analysis, and study of a recent vintage, has been accomplished.

Scope is a fourth dimension for considering the work done to date. Scope could encompass many considerations, such as the studies' comprehensiveness: in considering the extant literature (and relating their findings to that literature); in studying building codes in context with other regulations; and in examining both the substantive and the administrative aspects of the building requirements.

In our review here, we only shall consider the last characteristic. The authors believe that it is particularly important to consider the administration of the building code.[x] Yet, this ideal of holistically examining both the substance and administration of the code is more often the exception. While many investigations do, indeed, touch upon some aspects of building code administration, this is typically of a limited, anecdotal fashion as opposed to a more empirical, in-depth study (e.g., the 1998 University of Illinois survey of building code enforcement).

In sum, gaps in the extant literature are found with respect to:

-- *Timeliness.* Much research is dated.
-- *Conceptual basis.* Limited benchmark and cost benefit study has been done to define what are "appropriate" versus "inappropriate" or "excessive" regulations.

-- *Methodology*. More quantitative investigation is needed.
-- *Scope*. More wide-ranging analysis is needed.

Our future research suggestions are aimed at addressing these gaps.

Conclusions: Future Research

Study of the Contemporary Application of Codes

Study of the contemporary scene is needed, and the following are offered as examples.

As earlier described, the model building codes have shifted from three (formerly four) regional-oriented codes to two national codes, promulgated by the ICC and NFPA. We need to understand how these national codes differ from one another, how the two national codes depart from the standards of the former regional-oriented codes, and the cost implications of the above.

Tables 5 and 6 start these lines of inquiry. Table 5 focuses on how new construction is regulated by the IBC 2003 and the NFPA 5000, 2003 edition. Table 6 considers how rehabilitation is regulated by the IBC (Chapter 34 and IEBC), NFPA (Chapter 15), as well as smart codes developed by New Jersey (Rehabilitation Subcode) and HUD (NARRP). (There are interrelationships between the above, such as the NFPA's Chapter 15 being based on the NARRP and Maryland's smart code.) Beside their comparisons of the respective regulations, both the new construction and rehabilitation tables contain a column briefly noting potential cost implications. In brief, the following may have significant cost impacts—that is, cost increases—in the regulation of new construction when compared to the earlier regional-oriented model codes:

-- Increased sprinkler requirements in multi-family housing in both IBC ([F] 903.2.7) and NFPA 5000 (25.3.5) by comparison to earlier model codes. There also is potential for added cost impact from the NFPA 5000 sprinkler requirement in the case of townhouses, which in some cases may be considered as apartment buildings under that code.
-- Introduction in both IBC (1909.1.4) and NFPA 5000 (35.9) of fenestration impact requirements in hurricane regions, which existed earlier only in southern Florida and along the coast of Texas.
-- Increased seismic requirements in both IBC (1613-1621) and NFPA 5000 (35.10) that affect regions of moderate seismicity.
-- Increased live loads on sloped roofs affecting multi-family housing (IBC 1607.11, NFPA 5000 35.7).
-- Increased complexity of structural design, due primarily to structural load standards, which may have more impact for NFPA 5000 in its effect on wood frame construction.

The following may have significant cost impact—that is, cost savings—in the regulation of building rehabilitation when compared to earlier model codes:

-- The adoption of a modern rehabilitation code is intended to improve the predictability of the applicable regulations while establishing proportionality between voluntary and mandated work. The differences between the four prototypes—New Jersey, NARRP, IEBC, and NFPA 5000 Ch. 15—is subject to further study. Potentially, New Jersey and NARRP may have the greatest impact on cost reduction, while IEBC may have less impact than NFPA.

The following may have significant cost impacts from differences *between* the current national codes:

-- Potentially different sprinkler requirements for townhouses between the IBC and NFPA 5000, with the latter being more restrictive.
-- Different plumbing requirements under the IBC (International Plumbing Code) and NFPA 5000 (Uniform Plumbing Code), with the latter being more restrictive.

One would need to do further empirical research to understand better the potential cost impacts cited above, and the following are offered as examples.

New Construction-Related Research

Identification and analysis of the impact of the latest seismic provisions on housing. Compare costs of new and "older" (e.g., former regional-oriented codes) provisions in mid-rise and low-rise apartment buildings in four seismic zones (California, Pacific Northwest, Memphis, and Maryland/Virginia); compare costs of new and older provisions in wood frame buildings.

This research will involve the identification of regionally typical building plans (a task requiring participation of contractors and homebuilders) and analysis by engineers experienced in seismic design of the reengineering of these prototypical buildings to meet the new seismic requirements. Cost estimators will be employed to estimate the costs of the various reengineered designs.

Identification and analysis of the effects of latest impact protection requirements in hurricane regions. Compare costs of new and older provisions in mid-rise and low-rise residential buildings in selected areas of the Gulf coast, Florida, and the Atlantic coast.

This research will be based on prototypical building plans to be developed. It will involve the participation of window manufacturers, shutter manufacturers, curtain wall consultants, and architects knowledgeable in the field of impact of windborne debris, and experienced in building design in the respective regions.

Identification and analysis of the impact of latest sprinkler requirements in multi-family housing. Compare the costs of new and older sprinkler requirements in the three regions of the former model codes.

This research will be based on prototypical building plans to be developed. It will involve participation of sprinkler manufacturers, fire protection engineers, and architects knowledgeable in the design and construction of garden apartments and other multi-family housing configurations.

*Identification and analysis of the impact of different plumbing codes. C*ompare costs of plumbing under NFPA 5000 (Uniform Plumbing Code) with those under the IBC's International Plumbing Code.

This research will begin with a detailed comparative analysis of the two codes in question. The geographical cost variables will be addressed by selecting several different regions of the country within which comparative cost analyses of the different required plumbing systems will be made.

Rehabilitation-Related Research

Identification and analysis of the impact of the adoption of a rehabilitation code. Analyze the impact of rehabilitation code adoption on removal of barriers to rehabilitation; analyze the impact of rehabilitation code adoption on the cost of housing rehabilitation; compare the rehabilitation code impacts in New Jersey, Maryland, New York, and Rhode Island.

This research will begin with identification of locations where rehabilitation codes have been adopted and enforced for at least two years. Of the four states mentioned, New Jersey and Maryland are definitely in this category. The other two states, along with other possible states and local jurisdictions, will be surveyed to determine if they meet the criteria. Prior or current rehabilitation code studies performed in New Jersey and elsewhere (e.g., NAHB/RC and University of North Carolina) will be reviewed. Potential measures of the removal of barriers to rehabilitation and cost impacts will be generated, tested, and validated. If possible, differential impacts related to specific rehabilitation code differences among the jurisdictions will also be identified and analyzed.

Identification and analysis of the impact of the FEMA Flood Insurance criteria on the rehabilitation of low and moderate cost housing. Survey and analyze of the impact of the FEMA Flood Insurance criteria on substantial improvement, which have found their way into both the IEBC and NFPA 5000 Ch. 15, on the rehabilitation of housing in the flood plane.

This research will begin with a survey of a representative sample of local jurisdictions located in flood planes. Jurisdictions that participate in the FEMA Flood Insurance Program and those that have opted out of it will be included in the sample. The purpose of the survey is to verify or refute some anecdotal evidence from Florida that basic improvements to low-cost housing in the flood plane, such as re-roofing and lead-based paint abatement, have been prevented from being implemented because of the high costs for added flood mitigation work imposed by the substantial improvement criteria of the FEMA Flood Insurance Program. If the survey confirms the existence of this problem, its extent will be quantified through an in-depth study. Recommended changes to the FEMA criteria, or at least to the way they are mandated in the building codes and rehabilitation codes (e.g., IBC and IEBC), may be generated such that FEMA's actuarial responsibilities and local low-cost housing policies can be harmonized.

Benchmarks and Cost Benefit Analysis

It is admittedly hard to establish consensus on the "benchmark" for appropriate building code standards and administration, but more work needs to be done in this area.

One possibility is simply to compile a list of innovative building materials and procedures, then examine if communities accept or reject the listed items. That was done earlier to good stead by the National Commission of Urban Problems (1968), Field and Ventre (1971), and Seidel (1978), and we need a contemporary version. The list of today's innovations could draw upon the cutting-edge building materials and practices already identified by Koebel, Papadakis, Hudson and Cavell (2003) in *The Diffusion of Innovation in the Residential Building Industry*. Another possibility is to draw from the innovations identified by the Joint Venture for Affordable Housing (JVAH). While the JVAH dates from the 1980s (NAHB Research Foundation, Inc. (1982)), it remains one of the most extensive efforts to date in examining how affordable housing could be produced by changing land use and construction practices. It would be interesting to examine if the JVAH's construction recommendations are allowed by local building codes. In a related vein, it would be interesting to study if the innovations first identified by the National Commission on Urban Problems (1968) and then reexamined by Field and Ventre (1971) are allowed today.

Another tack for developing a benchmark for appropriate standards is to work backward from the desired "end model" of the affordable housing unit. There is reasonable agreement that the most affordable types of shelter consist of "reinventing" the SRO (Downs 1991) and allowing accessory housing, such as "granny flats," or other affordable configurations (e.g., Boston "triple decker," or a four-story combustible building in New York City). One should analyze how the building codes restrict production of these affordable units.

The identification of benchmark standards for building codes, however accomplished, would benefit from cost-benefit study. The only way to analyze if the new national code requirements earlier identified with respect to seismic, impact protection and sprinkler requirements are "appropriate" is to do some type of cost-benefit comparison.

Other observers similarly call for cost-benefit study with reference to the building code. After considering more stringent proposed seismic standards in the New Madrid seismic zone,[xi] Stein and Tomasello (2004, A13) argued that "over it's approximately 50-year life, a building in Memphis (located in New Madrid) loses about one percent of its value because of earthquakes, while the new code could increase a building's cost five percent to 10 percent. . . . An objective assessment by outside analysts . . . could realistically estimate the hazard and the costs and benefits of various earthquake codes."

We acknowledge the challenges to such cost-benefit[xii] investigation. There is disagreement as to who, or whom the costs or benefits accrue; data are limited (e.g., the insurance industry guards relevant incidence and loss information); there are a host of methodological and calculation issues (e.g., costs and benefits occur at different points in time, raising issues of life-cycle analysis); and, in many cases, the benefits are probabilistic (e.g., the benefits of reduced earthquake losses will not be realized if the earthquake does not occur). Still, the groundwork for cost-benefit study in relationship to building codes has been established (McConnaughey (1978)) and the subject of what are appropriate standards will not get beyond finger pointing without some cost-benefit investigation.

This type of investigation can benefit from data and models developed for other purposes. For example, FEMA has spent much time and effort developing a Natural Hazard Loss Estimation Methodology (HAZUS) that estimates losses from natural disasters, such as earthquakes, floods, and storms. Perhaps, the HAZUS could be tapped to conduct a cost-benefit study on the new national building code requirements regarding seismic design and windborne debris impact protection.

Here are two examples of such research:

1. Life-cycle cost/benefit analysis of natural disaster mitigation provisions in I-codes and NFPA 5000

   -- Develop an appropriate life-cycle cost/benefits model that accounts for the probabilistic nature of the benefits
   -- Apply the model to current seismic and/or hurricane design provisions in the codes

   This research would build on life-cycle cost/benefit analysis performed by NIST Building and Fire Research Laboratory's Applied Economics Division, and the standard models developed by them at ASTM.

2. Application of HAZUS to analysis of the regional impacts of the current code requirements for seismic design, flood design, and/or wind design.

   -- Determine the applicability of HAZUS to this type of analysis
   -- If applicable, carry out runs in regions where seismic data and building inventory data are recognized as being reliable

   This research will require a variety of assumptions. Since HAZUS models the effect of a specified natural disaster on a regional inventory of buildings and infrastructure, the effect of assuming that the entire building inventory complies with new code requirements may be unrealistic. Assumptions will have to be made regarding the diffusion rates of new building design into an existing inventory. Nevertheless, HAZUS is a powerful tool, and sensitivity analyses of various sets of assumptions may be useful and enlightening.

Empirical Data and Quantitative Analysis

More empirical data is needed on the subject, as well as quantitative analysis on how codes affect housing.

To illustrate, contemporary information is needed on the local implementation of building regulations, including if a local jurisdiction has a code, the basis of that code, the profile of officials implementing the regulations (e.g., background, education, and civil service status), as well as other details (e.g., prohibited and permitted materials and procedures, as described earlier). The last national comparable survey of that type dates from the late 1960s to the early 1970s (National Commission on Urban Problems (1968); Field and Ventre (1971)), and clearly a contemporary equivalent database is needed.

With such data, we can effect, in a contemporary setting, the quantitative analysis of how building regulations and their administration affect housing. In essence, one can revisit, with current data, the Noam (1981) regression study.

It is further potentially possible to tap existing data to statistically analyze how codes influence housing. To illustrate, the ISO (see page 4 for a brief description) has developed a Building Code Effectiveness Grading Schedule (BCEGS) for most communities in the U.S.. The BCEGS assesses the substantive basis of the building codes in a particular community (e.g., are codes based on a current edition of a model code?), as well as how well a community enforces its building codes (e.g., code official qualifications, training, and staffing levels). The BCEGS has a 1 to 10 ranking, with 1 representing "exemplary" achievement.

It may be worthwhile to replicate the essence of the Noam model with BCEGS data. The value of housing (V) is a function of the effectiveness of the building code (E).

$$V = f\,(E_1, X_1)$$

Where E is a continuous variable measuring code effectiveness (using the BCEGS 1 to 10 ranking) and X_1 is a vector of other factors that contribute to housing prices (e.g., housing amenities). If an effective local building code, such as one based on the latest version of the model code that is administered by a well-trained staff, is presumably associated with more efficient housing production, then communities with lower (i.e., better) BGEGS rankings should be characterized by lower housing costs.

The above approach is not without its drawbacks. There is the practical problem that ISO has thus far only released the distribution of BCEGS rankings on a statewide basis. To do the analysis sketched above requires the micro, community-level BCEGS rankings. (Perhaps HUD could request ISO to make the community level rankings available.) Also, we need to better understand how the BCEGS rankings are assigned. For instance, if a community adds its own hurricane protections over and above the model code regulations, does that enhance (i.e., make lower) the BCEGS ranking? If so, then a low BCEGS score may not necessarily be associated with lower local housing costs.

These issues can be resolved, and it behooves researchers to examine the potential application of BCEGS data to examine the impact of codes.

Scope of Research

A broader scope of research with regard to building codes and housing is needed. This encompasses numerous dimensions.

More attention needs to be paid on both the substance and the administration of the code. The latter, unfortunately, has often been shortchanged. For instance, both the New Jersey rehabilitation subcode and the NARRP share many similarities (see Table 6). They differ, however, in terms of format. The New Jersey subcode is organized by occupancy classification, while the NARRP is organized by scope of work. Some observers (Kaplan 2003) have suggested that because of its one-stop organization by occupancy, the New Jersey subcode is easier for code officials to administer. That purported difference can be tested empirically by having code officials work on a series of rehabilitation situations, using first the New Jersey regulations and then the NARRP (or perhaps the Maryland Smart Code, which is based on the NARRP).

Macro-scale data pertaining to code administration is admittedly hard to come by, however certain potential sources should be explored. As noted, the BCEGS ranking covers numerous administrative characteristics. The multi-year research by the National Conference of States on Building Codes and Standards regarding regulatory streamlining may be another asset for researching code administration. And future research on the topic of code administration would be well served by considering the work by Burby (2003, 2000) on this subject.

An expanded scope of research considering the administrative side of the code also should tap into the literature on the diffusion of innovation. Many extant studies on the impact of codes on housing presume that if a cost-saving material or procedure is available, it will be used—but for code restrictions. The diffusion of innovation literature paints a murkier picture; cost-saving techniques may be resisted because of inefficient information, builder inertia, inadequacy of skills, perceived rejection by housing consumers, as well as because of code barriers (Oster and Quigley (1976); Koebel, Papadakis, Hudson and Cavell (2003)). That murkier reality must be acknowledged in future research on how the building code affects housing.

An expanded scope of research on the subject also should include the potential interaction of HUD policies, codes, and housing. For instance, despite many reforms, the 25-50 percent rule still lurks. Since Davis-Bacon requirements for subsidized housing increase labor costs, that federal mandate may inadvertently "push" more subsidized rehabilitations to comply with more stringent requirements. Further, it also has been reported (Listokin and Listokin (2001)) that code administrators lean toward a more stringent interpretation of the building code when dealing with subsidized projects. For example, in Florida, building inspectors demanded the replacement of still serviceable roofs and windows in homes being rehabilitated with Community Development Block Grant (CDBG) funds (Listokin and Listokin (2001)). The inspectors leaned to a strict interaction of the housing code because they felt that with HUD subsidy, "the money is then available and the job can be done right." Thus, the very fact that housing is subsidized may exacerbate code problems.

As is evident from the above discussion, there are many overdue and fruitful areas for studying how building codes affect housing costs. As researchers, we are true to our calling by recommending "more research." At the same time, perspective is in order. Many regulations other than building codes affect the cost of new housing, including zoning and subdivision requirements, as well as impact fees. Past research suggests, and we would concur, that these other regulations are more consequential with respect to new construction than building codes (that may not be the case with respect to rehabilitation of existing housing). Future research efforts and funding should reflect the differential impact of the various regulations; consequently, while studying building codes is not the highest priority, it should continue to remain a near the top of the priority list.

Table 1
Overview of Contemporary National Model Building Code Regulation of New Construction and Rehabilitation (2004)

	ICC		NFPA
	International Building Code (IBC)	International Existing Building Code (IEBC)	NFPA 5000
New Construction	Applicable to all buildings	N/A	Applicable to all buildings
1- & 2-family housing and town houses	Reference to Int. Residential Code (IRC) that recognizes industry standard for conventional wood frame construction.		Reference to IRC for 1- & 2-family only; townhouses must be engineered and can't use conventional construction, but this is up to interpretation.
Multi-family housing	Compliance with fire safety standards, structural load standards, and materials standards.		Essentially same as IBC, with minor differences in heights and areas, sprinkler and standpipe triggers, etc.
Existing Buildings	Chapter 34, applicable to repairs, alterations, additions, and change of use (unless IEBC is adopted).	Applicable to all buildings undergoing repairs, alterations, additions, and change of use. Based on NARRP, with added requirements.	Chapter 15, applicable to repairs, alterations, additions, and change of use. Based on NARRP & Maryland Bldg. Rehab. Code.

N/A = Not applicable

Table 2
Building Code Categories by State

Building Codes Adopted by State, For Most Structures					Building Codes Adopted Locally
Local Amendments Allowed	Local Amendments as Approved by the State	Mandatory Statewide, No Local Amendments	Mandatory if Adopted Locally	Government Buildings Only	
Arkansas	Utah	Virginia	West Virginia	Vermont	Texas
Alaska	South Carolina	Rhode Island	North Dakota	South Dakota	Maine
California	Oregon	New Jersey	Montana	Nebraska	Illinois
Florida	North Carolina	Kentucky	Minnesota	Missouri	Hawaii
Louisiana	Massachusetts	Connecticut	Michigan	Mississippi	Delaware
Maryland	Indiana	Pennsylvania	Idaho	Kansas	Arizona
Nevada	Georgia		Colorado	Iowa	
New Hampshire	New York			Alabama	
New Mexico				Oklahoma	
Ohio					
Tennessee					
Washington					
Wisconsin					
Wyoming					

Source: National Conference of States on Building Codes and Standards 2004
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Table 3
Excerpts of Alleged Building Code Impacts in Selected Recent State-Local Housing Studies

Jurisdiction	Building Code Description/Impact
New York City	"New York City's building code is stringent, voluminous, detailed, complex and arcane" (Salama, Schill and Stark 2001, XVII). "The current code is outdated and archaic. The current code is 8,000 pages long. It has not been overhauled since 1968; it requires building technologies that are woefully out of date; and it doesn't permit cost saving technologies that have recently come into being" (Schill 2002, 5).
Boston/Massachusetts	"A set of boards and commissions, each promulgating its own specialty codes regulates building. . . . Because of limited manpower . . . lack of common training . . . and the vagaries of local political culture, local implementation is uneven. . . . Idiosyncratic interpretation introduces a level of risk that gets translated into added costs" (Euchner and Frieze 2003,VII).
Colorado	Housing costs could be reduced via the following code changes: modifying requirements for materials and construction, modifying quality standards (e.g., allow SROs), and develop rehabilitation sensitive codes (Colorado Department of Local Affairs 1998)
Oregon	"Building codes have been criticized for: a). Lack of uniform interpretation, which contributes to difficulty obtaining plan review and permits, expensive contract corrections, and increases construction time; b). Penalizing owners of older buildings for renovations by requiring expensive upgrades; c). Lack of a cost/benefit analysis when code changes are adopted and implemented; and d). Difficulty changing specific code standards when new technologies, building techniques and building materials could be used to reduce costs while maintaining safety" (Metro Council 2000, 55).
Montana	Enhanced building code interpretation and substantive code changes (e.g., concerning basement wall insulation and stairway lighting) could reduce costs of an average home by $5,300 (State of Montana Affordable Housing/Land Use Initiative 2000).

Table 4
Analysis of Selected Literature on Building Codes and Housing Costs

Selected Studies	Study Characteristics							
	Methodology				**Conceptual Basis**		**Scope**	
	A	CS	SU	ST	Benchmark Standard	Cost Benefit	Standards	Administration
Babcock and Bosselman (1973)	X				N.S.	No	X	No
Presidents Commission (1982)	X				Model?	No	X	Limited
Advisory Commission (1992)	X				Model?	No	X	Limited
Comprehensive Plans (1990s-2000s)	X				N.S.	No	X	Limited
Massachusetts (2000, 2002)		X			Model?	No	X	Extensive
Salama et al (2001)		X			Model?	No	X	Moderate
Euchner (2003)		X			Model?	No	X	Extensive
Douglas (1968)			X		Model-Other	No	X	Moderate
Field-Ventre (1971)			X		Model-Other	No	X	Moderate
Seidel (1978)			X		Model-Other	No	X	Moderate
Illinois (1998)			X		Model	No	X	Extensive
Muth-Wetzler (1976)				X	Model	No	X	Limited
Noam (1982)				X	Model-Other	No	X	Limited
Burby et al (2003)				X	Model-Other	No	X	Extensive

Note:
A: Anecdotal
CS: Case Study
SU: Survey
ST: Statistical
N.S.: Not specified.
Model= Model code

Table 5: Analysis of Contemporary National Model Building Code Regulation of New Construction

Provisions	IBC 2003	NFPA 5000, 2003 Edition	Cost Impacts
Applicability	New buildings in all occupancies. Detached one- and two-family dwellings and townhouses referred to the IRC.	New buildings in all occupancies	
Fire and life safety	Expansion of requirements for sprinklers, especially in residential construction. Sprinklers required in all R occupancies except those designed to the IRC (one- and two-family dwellings and townhouses).	Expansion of requirements for sprinklers, especially in residential construction. Sprinklers require in all residential occupancies except one- and two-family dwellings and some townhouses. Note that many townhouses are considered apartment buildings under NFPA 5000.	Both have added sprinklers to the cost of housing in comparison to earlier model codes. NFPA may have added impact for townhouses.
Loads:			
-- Wind	Wind load requirements refer extensively to ASCE 7. They are evolving and becoming more complex, while increasing in some respects and decreasing in others. Significant new requirement is the addition of window impact protection in hurricane areas.	Wind load requirements refer almost entirely to ASCE 7. They are evolving and becoming more complex, while increasing in some respects and decreasing in others. Significant new requirement is the addition of window impact protection in hurricane areas, but buildings designed on basis of wind tunnel tests inadvertently omit the impact protection (due to ASCE 7 inadvertent omission.	Both have added impact protection requirements to windows in hurricane areas in comparison to earlier model codes. No significant difference between IBC and NFPA.
-- Seismic	Seismic requirements, based on NEHRP provisions, have increased in both complexity of analysis and severity (based on changes to the seismic map).	Seismic requirements refer entirely to ASCE 7. They have increased in both complexity of analysis and severity (based on changes to the seismic map)	Both have significant added cost in moderate and lower seismic zones, and possibly significant added cost to wood frame buildings in comparison to earlier model codes. No significant difference between IBC and NFPA.
-- Snow	Snow load requirements refer extensively to ASCE 7. They are evolving and becoming more complex, while increasing in some respects and decreasing in others.	Snow load requirements refer almost entirely to ASCE 7. They are evolving and becoming more complex, while increasing in some respects and decreasing in others.	For both, possibly no significant added costs, except for the added complexity of engineering design.

Continued on next page

Table 5 (continued)

-- Vertical (live)	Live load on sloped roofs increased significantly in IBC but not in IRC. (For a slope of 4/12 load increased from 16 to 20 psf.	Live load on sloped roofs increased significantly.	For both, significant added cost in multifamily housing compared to earlier codes.
Materials	References to consensus standards.	References to consensus standards.	
Accessibility	Dwelling units must comply with ANSI A117.1, except for detached one- and two-family dwellings.	All buildings must comply with ANSI A117.1.	For both no added cost compared to earlier model codes.
Energy Conservation	Reference to the *International Energy Conservation Code*. One- and two-family dwellings and townhouses may meet requirements of Chapter 11 of IRC.	Multifamily buildings must meet requirements of ASHRAE 90.1. One- and two-family dwellings must meet requirements of Chapter 51 or ASHRAE 90.2.	NFPA may possibly impose greater cost than IBC and IRC.
Plumbing	Reference to the *International Plumbing Code*. One- and two-family dwellings and townhouses must meet Part VII of IRC.	Reference to 2000 *Uniform Plumbing Code*. Reportedly more restrictive than IPC.	By being more restrictive, NFPA may impose greater cost than IBC and IRC.
Mechanical	Reference to the *International Mechanical Code*. One- and two-family dwellings and townhouses must meet Part V of IRC.	Reference to 2000 *Uniform Mechanical Code*.	Different cost impact must be determined by further analysis.
Electrical	Reference to the ICC *Electrical Code*. One- and two-family dwellings and townhouses must meet Part VIII of IRC.	Reference to *National Electrical Code*.	Probably no difference between the two, and significant cost increase.
Housing Requirements:			
-- Multifamily	Compliance with fire safety, structural loads, and materials requirements.	Essentially same as IBC, with minor differences in heights and areas, sprinkler and standpipe triggers, etc.	See fire and life safety, seismic loads, vertical loads, and plumbing above.
-- SRO	Classified as R-1 (hotels) if transient and R-2 (apartments) if nontransient.	Classified as Lodging or Rooming House if occupied by 16 or fewer people on transient or nontransient basis. Larger occupancies are classified as Hotels.	See fire and life safety, seismic loads, and vertical loads above. Differences require further analysis.

Continued on next page

Table 5 (continued)

-- 1- & 2-family housing and town houses	Reference to Int. Residential Code (IRC), that recognizes industry standard for conventional wood frame construction. Cost impact of new seismic requirements (NEHRP) still unknown.	Reference to IRC for structural design of 1- & 2-family only; townhouses must be engineered and can't use conventional construction, but this is up to interpretation. Cost impact of new seismic requirements (ASCE 7) still unknown.	Potentially greater cost impact of NFPA in case of townhouses.
-- Modular	Treated like site built, except for the acceptance of off-site inspection in the enforcement..	Treated like site built, except for the acceptance of off-site inspection in the enforcement.	See seismic loads, wind loads, and plumbing above.
-- Manufactured	In IBC, Regulated only in Appendix G, Flood-Resistant Construction. In IRC, Appendix E, Manufactured Housing Used as Dwellings.	Generally not addressed, except for energy efficiency, flood resistance and electrical systems modifications.	Differences between IBC and NFPA require further analysis.

Table 6
Analysis of Contemporary National-State-Model Building Code Regulation of Rehabilitation

	N.J. REHABILITATION SUBCODE	NARRP 1997	IBC Ch. 34 2003	IEBC 2003	NFPA 5000 Ch. 15 2000	Cost Impacts
Applicability	All work in existing buildings	All work in existing buildings	All work in existing buildings, unless IEBC is adopted	All work in existing buildings, if adopted	All work in existing buildings	
Format	The bulk of the subcode addresses reconstruction & is organized by occupancy classification.	Chapters organized by rehabilitation category of work.	Small chapter organized into sections.	Chapters organized by rehabilitation category of work.	Sections organized by rehabilitation category of work.	Some argue NJ format more user-friendly.
Regulations governing alterations	Alterations divided into 3 categories, as a function of the extent and nature of the work: -- Renovation -- Alteration -- Reconstruction Requirements increase respectively. At lower end, existing conditions that violate the building code may be continued, but not made worse. Reconstruction triggers specified life safety improvements within the work area, and when the work area exceeds specified percentages, the life safety improvements extend beyond the work area to other parts of the building.	Alterations divided into 3 categories, as a function of the extent and nature of the work: -- Renovation -- Alteration -- Reconstruction Requirements increase respectively. At lower end, existing conditions that violate the building code may be continued, but not made worse. Reconstruction triggers specified life safety improvements within the work area, and when the work area exceeds specified percentages, the life safety improvements extend beyond the work area to other parts of the building.	Alterations must conform to new construction requirements and not cause building to be in violation of code. Parts of buildings not affected by alteration not required to comply, except "Substantial improvements" to buildings in flood plain trigger full compliance of building with flood design requirements for new construction. Nonstructural alterations may be made using same materials if no adverse effect on structural member or fire-resistance.	Alterations divided into 3 categories, as a function of the extent and nature of the work (similar, but not identical to NARRP): -- Alterations Level 1 -- Alterations Level 2 -- Alterations Level 3 Requirements increase respectively. Levels 2 and 3 trigger specified life safety improvements within the work area, and when the work area exceeds specified percentages, the life safety improvements extend beyond the work area to other parts of the building. "Substantial improvements" to buildings in flood plain trigger full compliance of building with flood design requirements for new construction. Extensive structural upgrades triggered by structural damage.	Alterations divided into 3 categories, as a function of the extent and nature of the work: -- Renovation -- Modification -- Reconstruction Requirements increase respectively. At lower end, existing conditions that violate the building code may be continued, but not made worse. Reconstruction triggers specified life safety improvements within the work area, and when the work area exceeds specified percentages, the life safety improvements extend beyond the work area to other parts of the building. Structural provisions "reserved" for the most part. "Substantial improvements" to buildings in flood plain trigger full compliance of building with flood design requirements for new construction (Ch. 39).	IBC not predictable; other four are. All but NJ and NARRP apply FEMA's "substantial improvement" trigger, and will have significant cost impact in the flood plane. IEBC has extensive cost impact from its structural damage repair requirements. Some argue the order of growing cost impact: NJ NARRP NFPA 5000 IEBC.

Table 6 (continued)

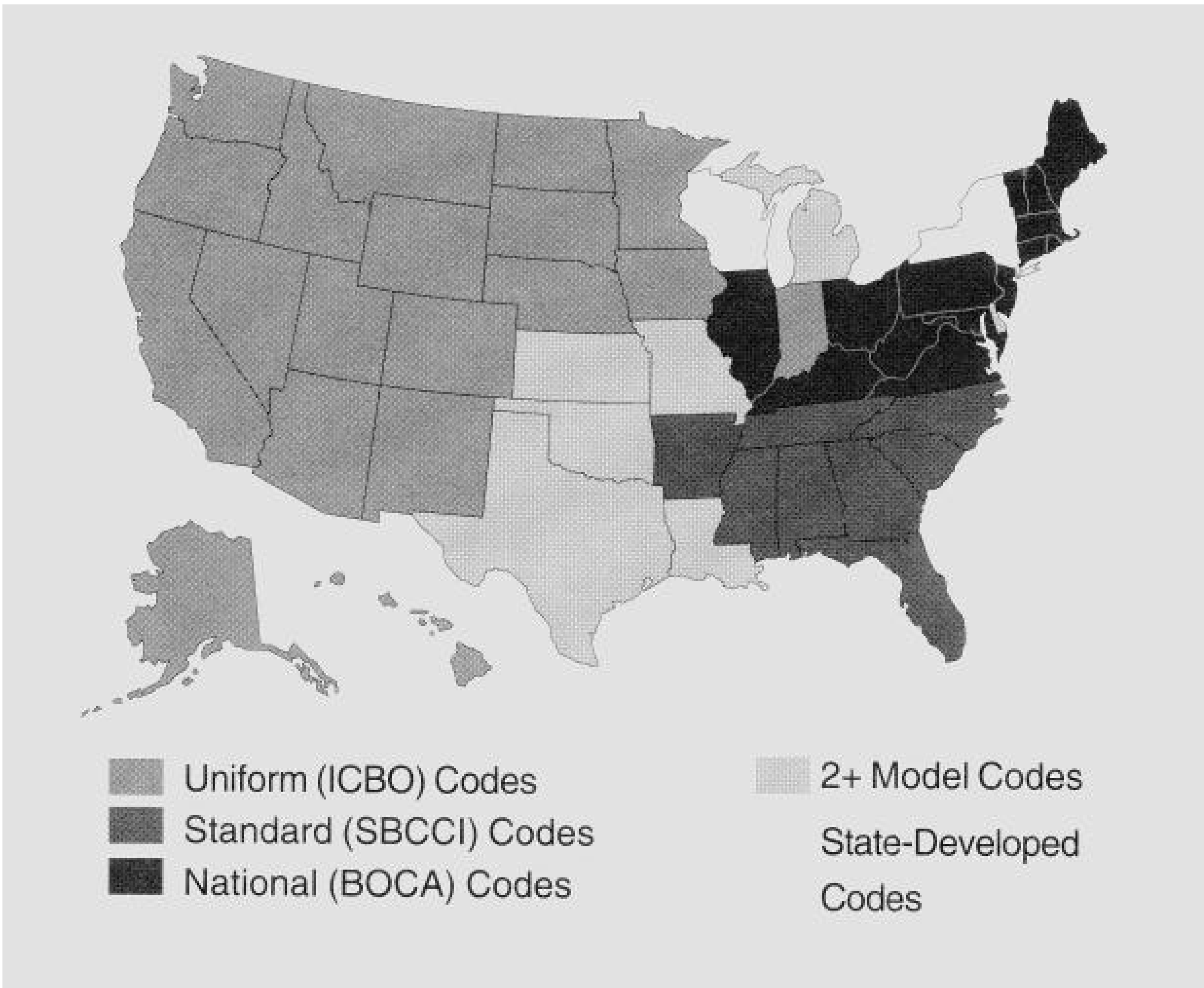
Regulations governing additions	Additions must conform to new construction requirements and not create or extend a nonconformity. Existing building plus addition to comply with heights and areas requirements, with up to an additional 25% for 1- and 2-story buildings.	Additions must conform to new construction requirements and not create or extend a nonconformity. Existing building plus addition to comply with heights and areas requirements, with up to an additional 25% for 1- and 2-story buildings.	Additions must conform to new construction requirements and not cause building to be in violation of code. Existing building plus addition to comply with heights and areas requirements.	Additions must conform to new construction requirements and not create or extend a nonconformity. Existing building plus addition to comply with heights and areas requirements.	Additions must conform to new construction requirements and not create or extend a nonconformity. Existing building plus addition to comply with heights and areas requirements.	All are essentially the same, except that NJ and NARRP allow up to a 25% increase in allowable area for 1- and 2- story buildings.
Regulations governing change of use	Use groups categorized into 6 hazard category tables. Compliance with selective requirements based on specific increases in hazards. Minimal requirements when hazards equal or reduced in all categories. New construction structural live load must be met when moving to a higher hazard category.	Use groups categorized into 4 hazard category tables (including seismic). Compliance with selective new construction requirements based on specific increases in hazards. Minimal requirements when hazards equal or reduced in all categories. New construction structural requirements (wind and snow) must be met when moving to a higher importance factor.	Buildings must comply with all the new construction requirements for the new occupancy. Building may accept less provided the new use is less hazardous "based on life and fire risk".	Use groups categorized into 3 hazard category tables (not including seismic). Compliance with selective new construction requirements based on specific increases in hazards. Minimal requirements when hazards equal or reduced in all categories. New construction structural requirements (wind and snow) must be met when moving to a higher importance factor (except when the change is to less than 10% of building area. Seismic requirements similar to NARRP with a few more exceptions.	Use groups categorized into 3 hazard category tables (not including seismic). Compliance with selective new construction requirements based on specific increases in hazards. Minimal requirements when hazards equal or reduced in all categories. New construction structural requirements (wind and snow) must be met when moving to a higher occupancy category. Seismic requirements similar to NARRP.	IBC not predictable. The rest are essentially the same.
Compliance alternatives	Owners may request a variation when compliance would result in practical difficulties.	Equivalent alternatives may be authorized by building official. Other alternatives may be accepted if compliance is infeasible.	Section 3410 provides a safety scoring system for 18 parameters.	Equivalent alternatives may be authorized by building official. Ch. 12 reproduces Section 3410 of the IBC.	Equivalent alternatives may be authorized by building official. Other alternatives may be accepted if compliance is infeasible or would impose undue hardship.	NJ, NARRP & NFPA allow for "infeasibility" Alternatives.

Continued on next page

Table 6 (continued)

Regulations governing repairs	Repairs may be made using like materials, except for a limited number of plumbing and electrical repairs, and replacement glass must comply with safety glazing requirements.	Repairs may be made using like materials, except for a limited number of plumbing and electrical repairs, and replacement glass must comply with safety glazing requirements.	No specific regulation, except that replacement glass must comply with all new construction requirements.	Repairs may be made using like materials, except for a limited number of plumbing and electrical repairs, and replacement glass must comply with safety glazing requirements. New construction structural requirements are triggered as a function of the extent of repair of structural damage.	Repairs may be made using like materials, except for a limited number of plumbing and electrical repairs, and replacement glass must comply with safety glazing requirements.	IEBC may have significant cost impact for repair of structural damage. Others are essentially the same.
Regulations governing historic buildings	Special variations may be granted to historic buildings when compliance will damage historic fabric.	Alterations and change of use may comply with reduced requirements based on filing a report demonstrating that compliance will damage historic fabric.	Alteration and change of use regulations do not apply if building official judges them "to not constitute a distinct life safety hazard".	Alterations and change of use may comply with reduced requirements based on filing a report demonstrating that compliance will damage historic fabric.	Alterations and change of use may comply with reduced requirements based on filing a report demonstrating that compliance will damage historic fabric.	All are essentially the same technically, but may vary in terms of administrative requirements for submissions.
Retroactive regulations governing all existing buildings	Not in scope of the New Jersey Rehabilitation Subcode, but recognizes currently existing fire code, housing code, and other retroactive regulations.	Not is scope of the NARRP, but recognizes currently existing retroactive regulations.	Compliance with Property Maintenance and Fire Codes.	Compliance with Property Maintenance and Fire Codes.	Section on retroactivity in Ch. 1 is "reserved". Use of Chapter 15 requires building to be legally existing.	All are essentially the same. None of them are retroactive, but they recognized locally adopted retroactive requirements.

Figure 1
Historical, Regional-Oriented Model Codes

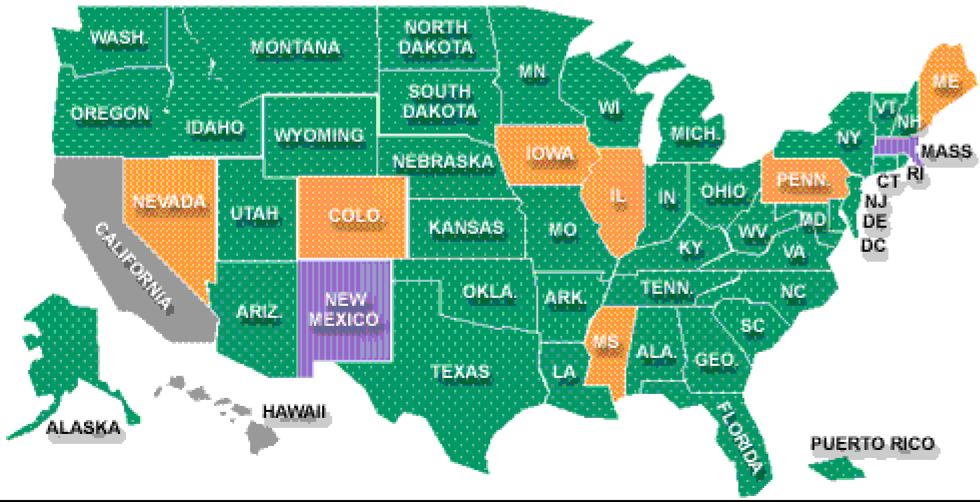


Source: National Conference of States on Building Codes and Standards, 2000.

Figure 2
Contemporary Adoption of the International Code

International Code Adoptions

?? 44 states and the Department of Defense use the *International Building Code*
?? 32 states use the *International Residential Code*
?? 32 states use the *International Fire Code*



One or more International Codes currently enforced statewide

One or more International Codes enforced within state at local level

Adopted statewide with future enforcement date

Source: www.iccsafe.org/cs/adoptions/adoption.html (accessed 12/5/03).

Figure 3
Building Regulations and Housing Cost

		I. Substantive Regulations	
		"Appropriate"	**"Inappropriate"**
II. Administration	**"Appropriate"**	Goal	Cost Inducing
	"Inappropriate"	Cost Inducing	Most Costly

Source: Modeled from Luger and Temkin (2000, 7)

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Endnotes

[i] Includes states with regulations governing any structure, including government buildings.

[ii] Zoning may increase the value of land and "high land values may themselves create regulation" (Glaeser and Gyourko (2003: 23)).

[iii] Impacts from zoning ordinances, environmental controls, growth controls, and subdivision regulations.

[iv] Impacts from building codes, energy conservation regulations, and zoning ordinances (minimum floor area).

[v] Impacts from settlement practices and regulations.

[vi] Consolidated plans must be filed by state and localities in order to receive federal funding for housing and community developments. The consolidated plans include a section of "governmental constraints."

[vii] While the Minnesota state building code only requires sprinklers when buildings are at least three stories high and have at least 16 units, many Minnesota communities require sprinkler systems in all apartment buildings with dwellings on three or more floors (Minnesota Office of the Legislative Auditor 2001, 43-44).

[viii] This was part of a broader effort at regulatory reform (see National Association of Home Builders (1987); Weitz (1982)).

[ix] Examples of such markers include local adoption of a rehabilitation code, land use regulations that permit manufactured and modular housing, and "use of a recent version (i.e., published within the last five years) of one of the nationally recognized model building codes . . . without significant amendment or modification" (Federal Register (2003: 66291)).

[x] While all housing regulations involve "administration," administrative challenges may be especially critical with respect to the building code because so many agencies are charged with some aspect of building regulations, and administrative discretion (e.g., granting a variance) is so vital to the process.

[xi] An area of more than 100,000 square miles, including parts of Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee.

[xii] For example, the issue of seismic risk in moderate and lower seismic regions of the country is not a simple one. Everyone recognizes the risk in California because of the frequency of damaging earthquakes that occur. In other parts of the country, damaging earthquakes are much less frequent, but great earthquakes may still occur. The strongest earthquake in recorded American history, the New Madrid Earthquake, started in December 1811 and affected the central part of the country—including the New Madrid seismic zone. During this earthquake, large areas sank, new lakes were created, and the Mississippi River reversed and changed its course. If this earthquake were to occur today, it would devastate St. Louis or Memphis, and cause extreme economic disruption to the nation.

In recent years, earthquake risk has been better understood, and has led to changes in the building code requirements for seismic design in such locations as the New Madrid seismic zone. The requirements are not as severe as in California, but they represent significant increases when compared to earlier codes.

A cost-benefit study was conducted to support these seismic provision changes. In the early 1990s, the insurance industry's Earthquake Project analyzed new construction and rehabilitation in Los Angeles and Shelby County (Memphis) that adhered to more stringent seismic provisions. This study demonstrated large favorable benefit/cost ratios for new construction in both Los Angeles and Memphis for all building types examined. The benefit/cost ratios for rehabilitation in Memphis were more ambiguous, depending on building type, structural materials, and whether or not, and how, deaths and injuries were to be accounted for in the analysis.

At about the same time, FEMA developed a benefit/cost model for seismic rehabilitation, and published four reports, two on commercial applications and two for federal applications. In a case study of a Veteran's Administration (VA) hospital in Memphis, the benefit/cost ratio of rehabilitation was below 1.0 for property damage. When adding the benefits of deaths and injuries avoided, the benefit/cost ratio turned significantly larger than 1.0.