# Building Codes and Housing

David Listokin
Rutgers University

David B. Hattis
Building Technology Inc.

## Abstract

*This article examines whether and to what extent building codes affect housing costs. It first describes these technical provisions, then considers how building codes could theoretically affect housing costs, and finally analyzes empirical studies on the subject. While the latter are dated and suffer from other limitations, the more rigorous quantitative analyses indicate that codes increase housing costs by 5 percent or less. Further, building codes are in a state of flux and we need to examine how the current generation of regulations affects housing. Thus, building codes merit contemporary investigation; however, these regulations have much less impact on housing costs compared to other regulations such as zoning and subdivisions requirements.*

## Introduction and Summary

This article considers the regulation of housing construction (single-family and multifamily, new construction and rehabilitation of existing buildings), focusing on the building code (a broad term specifically defined in this article). It first describes the building code and then traces its history. The history of the building code is important because numerous events and disparate parties have shaped the code, which currently is in a state of evolution. The code is moving toward two national model templates that influence local building code regulations, and away from the three regional-oriented model codes that have been 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. Examples of the former include restrictions of cost-saving materials and technologies and barriers to mass production; the latter encompasses such barriers as administrative conflicts among different administering parties (for example, building and fire departments) and inadequately trained inspectors.

The literature on the subject of building codes and housing presents many examples of such impediments. Studies find that code inadequacies increase the cost of new housing from roughly 1 percent to more than 200 percent. The more quantitative analyses find code-related housing cost increases of 5 percent or less.

Though informative, the literature to date suffers from gaps in timeliness, conceptual basis, methodology, and scope. Much research describes the code world of yesteryear, rather than the current situation of two national model codes influencing the regulations. Conceptually, limited "benchmark" and cost-benefit study has been conducted 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 (for example, study of only the regulations, but not their administration). Similarly, some studies have been carried out by parties with proprietary interests, 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 among the various emerging "smart code" regulations affecting building rehabilitation, such as the New Jersey Rehabilitation Subcode and the Nationally Applicable Recommended Rehabilitation Provisions (NARRP). This analysis should include evaluation of the empirical results from adoption of smart codes (for example, enhanced renovation activity) in New Jersey, Maryland, and other states.

3. Analyze potentially lingering onerous building code provisions regarding rehabilitation. For example, "substantial improvement" may trigger (under governing Federal Emergency Management Administration [FEMA] and rehabilitation code provisions) expensive new requirements for flood plain and seismic design.

4. Include cost-benefit study in building code research. For example, 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; requirements above these benchmarks would constitute excessive regulations.

5. Work backward from the desired end model of the affordable housing unit—another tack for developing a benchmark for appropriate standards. We can agree that the most affordable types of shelter consist of reinventing the single room occupancy (SRO) dwelling and allowing accessory housing, such as "granny flats," or other affordable configurations (for example, the Boston "triple decker"); therefore, we should analyze if and how building codes restrict production of these affordable units.

6. Gather more empirical data on the subject and conduct quantitative analysis on how codes affect housing. For example, 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 (for example, background, education, and civil service status), as well as other details (for example, prohibited and permitted materials and procedures). The last national comparable survey of that type dates from the late 1960s to the early 1970s. A contemporary database could be created through a new survey and/or by 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. When researching the subject, 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 literature on diffusion of innovation 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 the future study of how the building code affects housing.

8. Add overall perspective to the many fruitful areas for building code research. In all likelihood, building codes have much less 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 (for example, accessibility for the disabled and manufactured housing), this regulation is legislated at the local or state government levels. It traditionally has been accomplished by means of a set of interrelated 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 for the installation of gas piping and gas-burning equipment.
- An energy code that addresses all parts of the building that consume energy or contribute to the consumption of energy.
- Other specialty regulations, such as an accessibility code, that address 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). 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, followed by plan review, permit issuance, inspections, and certificate of occupancy issuance.

At times, a related but different set of regulations that control the use and maintenance of existing buildings is packaged with the above measures. Since parts of these codes may overlap with plumbing, mechanical, or electrical codes, some aspects of operation and maintenance may be included in the codes. They generally can be described as follows:

- A fire prevention code, sometimes called a fire code, that 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.

Retroactive regulations form another category, generally addressing hazards in existing buildings that, while not necessarily imminent, are identified by society as needing remediation. Some examples of such regulations 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. Because of the extremely high costs imposed by such regulations on building owners, retroactive regulations are quite rare and local in nature.

In this article, the term *building code* is broadly used to refer to the entire set of interrelated building-related requirements described above, although such usage may not be technically correct.

## Historical Development

The current building regulatory system in the United States is the product of several diverse trends. From a historical perspective, it may be thought of as resting on four foundations, supported by three buttresses. Allegorically, then, the system rests on the following four foundations:

1. The insurance industry.
2. The tenement and housing movements.
3. The engineering profession.
4. The construction industry.

The following three buttresses support the foundation of the system:

1. The federal government.
2. The model code groups.
3. The voluntary consensus standards organizations.

### *The Insurance Industry*

In the 19th century, the insurance industry regulated fire safety in buildings with an institutional framework created to regulate, as well as to provide research and technical support. For more than 50 years, the regulation of fire safety in buildings has been a function of state or local governments, while some of those original 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 Underwriters Laboratories Inc. These organizations were first concerned with property risk and the risk of conflagration. Concern for life safety became articulated and institutionalized in 1913. In 1905, the National Board of Fire Underwriters developed and published the first model building code in the United States. The National Building Code, which also included housing and structural requirements in addition to fire safety, was updated and published until 1976.

The insurance industry also was the earliest regulator of electrical safety in building, consolidating the diversity of early local regulations when many entities came together to create the first National Electrical Code® in 1897 in a conference that anticipated 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 & Home Safety was created specifically to support the development of regulations in the natural disaster areas of earthquakes, hurricanes, and floods. The Insurance Services Office, Inc., evaluates building code enforcement programs in states and local jurisdictions throughout the United States and provides relative ratings to assist with insurance underwriting.

### *The Tenement and Housing Movements*

Tenement and housing movements arose in various U.S. cities toward the end of the 19th century in response to blatantly unhealthy housing conditions. In 1900, many charitable organizations joined together to form the National Housing Association to press for housing reform. Tenement laws developed in U.S. cities in the second half of the 19th century and, in the early years of the 20th century, began to reflect the concern for housing reform by regulating health and sanitation, as well as the fire safety aspects of housing. The New York Tenement House Act of 1901 served as model legislation for many other cities.

Tenement laws also were included in the 1905 National Building Code. Since 1939, the American Public Health Association has been concerned with housing standards and usually is credited with developing 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 regulation of room dimensions and arrangements has been reduced in scope, based on the assumption that they are 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 methods were accepted by a consensus of the profession and 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), and plumbing codes and standards (American Society of Plumbing Engineers).

### *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 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 the 1870 code of Washington, D.C. 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 Plumbing-Heating-Cooling Contractors–National Association, successor to the National Association of Master Plumbers, has been publishing the National Standard Plumbing Code, used in many jurisdictions, since the 1970s.

The National Association of Home Builders (NAHB) has a longstanding interest in building codes that affect home construction activity and the ability of homeowners and apartment dwellers to secure affordable shelter.

### *The Federal Government*

The federal government has played two roles in buttressing the current building regulatory system: (1) provider of technical expertise and (2) 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's 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), greatly influencing subsequent modern codes. Since then, NIST has continued to develop technical materials in various areas directly usable by the building regulatory system. Today, NIST leads or participates 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.

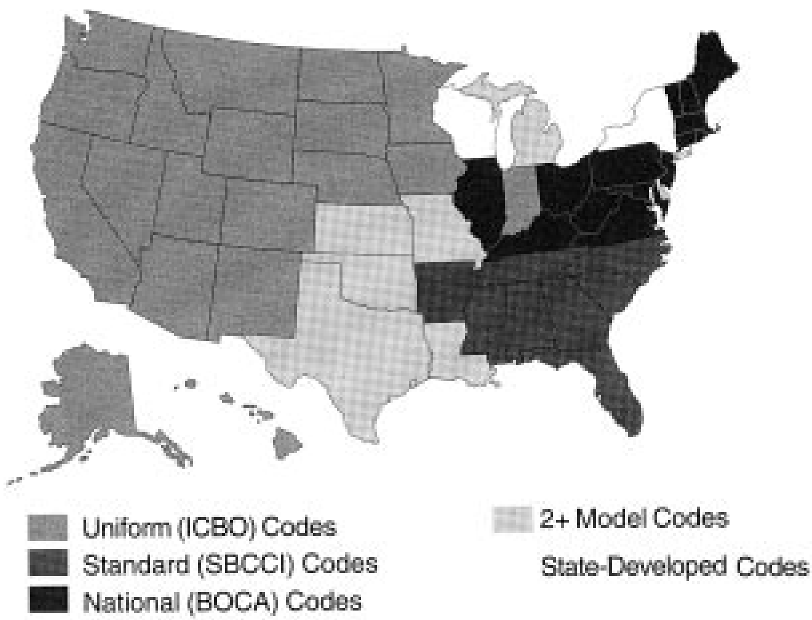
As formulators of national policies, various federal agencies have often interfaced with building regulations or influenced them directly. Notable in this capacity is the U.S. Department of Housing and Urban Development (HUD), which developed its own Minimum Property Standards for underwriting its mortgage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

*The Model Code Groups*

The original three regional model code groups—Building Officials and Code Administrators (BOCA) International, Inc., International Conference of Building Officials (ICBO), and Southern Building Code Congress International, Inc. (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 Exhibit 1). These organizations began developing model codes in response to 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, and encouragement from industry and government. BOCA, founded in 1915, published its first model building code, the Basic Building Code, in 1950. ICBO, founded in 1922, published its first model code, the Uniform Building Code, in 1927. SBCCI followed shortly thereafter with publication of the Standard Building Code in 1945.

## Exhibit 1

Historical, Regional-Oriented Model Codes




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

Until 1994, when the three regional groups joined together, 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 a stake in building design and construction. These amendments would be heard and debated before code change committees, and ultimately would be voted on 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 3 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. A few of the organizations involved in this process are ASCE, ASTM, ASHRAE, and NFPA. These organizations establish committees to develop and maintain specific standards. Standards, which can be proposed by anyone with an interest or stake in building design and construction, are debated in the committees and voted on in a process that attempts to ensure balance among the various stakeholders (for example, producers, consumers, and general interest groups).

## 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-oriented 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. Originally entitled the One and Two Family Dwelling Code [sic], the name was changed to the CABO One and Two Family Dwelling Code [sic] 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), to maintain and publish this code. The code continued to be published and updated until the establishment of the International Code Council (ICC) 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 United States is not known, for the past 30 years a single model code governing this type of construction throughout the country has existed.

### *Regulation of Factory-Produced Housing*

Initiated in the 1970s, factory-produced housing, whether panelized, modular, or manufactured (mobile homes), has increased in recent years. The production of components or entire houses in a remote factory and subsequent delivery to the site, which may be in a different state, require specialized regulatory procedures. Inspection for code compliance must be performed 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 house is to be 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 preemptive federal manufactured Home Construction and Safety Standards, or ‘HUD-Code,’ and the era of ‘manufactured homes’ began” (NAHB Research Center, Inc., 1998: 4). The Manufactured Housing Improvement Act of 2000 required that the HUD-Code regulation be updated regularly and called on states to implement installation standards and the training and licensing of home installers (Manufactured Housing Research Alliance, 2003). These changes reflected the rising amenity level of manufactured homes (prompting the updating of the HUD-Code) and the necessity of installation standards, because the original HUD-Code did not regulate installation and varying local standards regarding installation had caused problems that affected the growth of the manufactured home industry.

In the past 5 years, two trends have been predominant: (1) the emergence of two model codes, and (2) the adoption of rehabilitation codes.

### *The Emergence of Two Model Codes*

In 1994, the three regional model code groups merged to become the International Code Council, and the ICC began producing a single family of codes: the International Codes, 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 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—amendments, which can be proposed by a variety of interested parties, are reviewed by code change committees and the membership at large.

In 2003, NFPA created the first edition of its own building code, NFPA 5000. NFPA used the same process for developing and modifying this code that was used in the development of voluntary consensus standards. An overview of the current ICC-NFPA regulatory framework, with respect to new construction and rehabilitation, is provided in Exhibit 2. NFPA 5000 references the ICC IRC for structural design of one- and two-family dwellings.

## Exhibit 2

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

| | International Code Council (ICC) | | National Fire Protection Association (NFPA) |
|---|---|---|---|
| | **International Building Code (IBC)** | **International Existing Building Code (IEBC)** | **NFPA 5000** |
| **New construction** | Applicable to all buildings. | N/A | Applicable to all buildings. |
| **One- and two-family housing and townhouses** | Reference to International Residential Code (IRC) that recognizes industry standard for conventional wood frame construction. | | Reference to IRC for one- and two-family only; townhouses must be engineered and cannot use conventional construction, but this requirement depends on interpretation. |
| **Multifamily 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.<br>Based on the Nationally Applicable Recommended Rehabilitation Provisions (NARRP), with added requirements. | Chapter 15, applicable to repairs, alterations, additions, and change of use.<br>Based on NARRP and Code. |

N/A = not applicable.

Building codes in the United States are in the process of shifting from regionally influenced multiple model codes (for example, BOCA, ICBO, and SBCCI), as is illustrated in Exhibit 1, to a system influenced by two competing national codes promulgated by the ICC and NFPA (Exhibit 3). This evolution represents an important change from the system that prevailed for decades.

## Exhibit 3

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.


Source: International Code Council, “International Code Adoptions”; http://www.iccsafe.org/government/adoption.html (accessed December 5, 2004)

Thus far, many more jurisdictions have adopted the I-Codes. An important exception is California, which has opted for NFPA regulations. The National Conference of States on Building Codes and Standards, Inc. (NCSBCS) has tried unsuccessfully to combine the ICC codes and NFPA regulations into one national code (National Conference of States on Building Codes and Standards, Inc., 2001).

### *The Adoption of Rehabilitation Codes*

In the past 20 years, rehabilitation activity in existing buildings has grown 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 addressed new construction. In the 1990s, it became clear that this form of regulation was often arbitrary and unpredictable, and it constrained the reuse of older properties. Beginning with 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.” In January 1998, New Jersey adopted its rehabilitation code. In May 1997, HUD published NARRP to serve as a model for developing 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 Exhibit 2). The extent of local adoption of these model rehabilitation codes is unknown at this time. These new codes are based on the principles of predictability and proportionality. Predictability states that clear rehabilitation code regulations would foster the accurate prediction of improvement standards and costs. Proportionality establishes a sliding scale of requirements depending on the level and scope of the rehabilitation activity, from repairs to reconstruction. The overall goal of the rehabilitation codes (considered in detail in a later section of this article) is to encourage the reuse of older buildings.

### *Prevalence and Framework of Building Codes*

In 1968, the U.S. National Commission on Urban Problems (1969) conducted a national survey of all local governments in the United States 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 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).

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." (National Conference of States on Building Codes and Standards, Inc., 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 for multifamily housing (Office of Building Standards and Codes Services, 1975). As of 2003, according to data provided by NCSBCS, 46 states had a state building code,[1] and of those, 28 such regulations governed single-family housing and 37 regulated multifamily housing. Of the 46 states with state building codes, 9 applied only to government-owned buildings, 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 I-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, 24 of the 46 states with state building codes fell into this category.)

Second, many state building codes applied only to certain categories of property, such as public buildings or exclusively multifamily 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 (see Exhibit 4 for the 22 states that did so), 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 (for example, the locality having to document the case for the modification); however, these requirements were not very demanding, and local modifications were common. Only a few 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 these few 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 (for example, Connecticut and New Jersey) different communities within a state may impose different building code requirements.

## Exhibit 4

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 | Georgia | Connecticut | Colorado | Alabama | Arizona |
| Alaska | Indiana | Kentucky | Idaho | Iowa | Delaware |
| California | Massachusetts | New Jersey | Michigan | Kansas | Hawaii |
| Florida | New York | Pennsylvania | Minnesota | Mississippi | Illinois |
| Louisiana | North Carolina | Rhode Island | Montana | Missouri | Maine |
| Maryland | Oregon | Virginia | North Dakota | Nebraska | Texas |
| Nevada | South Carolina | | West Virginia | Oklahoma | |
| New Hampshire | Utah | | | South Dakota | |
| New Mexico | | | | Vermont | |
| Ohio | | | | | |
| Tennessee | | | | | |
| Washington | | | | | |
| Wisconsin | | | | | |
| Wyoming | | | | | |

Source: National Conference of States on Building Codes and Standards, Inc. (2004)

### *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 International Building Code (IBC) 2003 states the following:

> **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 (1977: 363), these benefits include "protecting the consumer from the consequences of their own ignorance" (for example, 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, or otherwise be hazardous. Some of these benefits can be achieved through other avenues, such as having potential housing consumers use professional inspectors to avoid unsafe dwellings. Also, property owners carry insurance against external dangers threatening the community at large. That private-based system, however, is surely not foolproof, for inevitably some consumers will not avail themselves of professional services and insurance. Hence, many, albeit far from all, accept the rationale of benefits accruing from building codes that argue for their promulgation (Colwell and Kau, 1982).

The benefit of realizing the various building code objectives are presumed to justify the costs imposed on building owners, occupants, and society. The debates about specific changes to the regulations, even the most blatant attempts to preserve or enhance proprietary market share, are usually couched in terms of this stated intent. We suffer, however, from a paucity of cost-benefit-analyses that might justify proposed regulations or changes to the regulatory status quo.

## Theoretical Description of the Ways Building Codes Could Affect Housing

As indicated in Exhibit 5, the idealized goal for building codes (or, for that matter, any regulation) is to incorporate appropriate substantive regulations and administer these regulations in an appropriate fashion. Deviation from this goal will add to housing costs; the greater the deviation, the greater the excess housing cost.

### Exhibit 5

Building Regulations and Housing Cost

| | | 1. Substantive Regulations | |
|---|---|---|---|
| | | **Appropriate** | **Inappropriate** |
| **2. Administration** | **Appropriate** | Goal | Cost Inducing |
| | **Inappropriate** | Cost Inducing | Most Costly |

Source: Modeled from Luger and Temkin (2000)

In a general sense, an appropriate building code would be one that protects the housing consumer and society in a balanced cost-benefit fashion.

The outline below frames in a more specific way the definition of inappropriate building codes from both a substantive (technical) and administrative perspective.

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

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

## Substantive Impediments

### *Require Questionable Improvements*

The “25–50 percent rule” governing rehabilitation is a classic example of requiring questionable improvement. This rule mandated that if investment in a building exceeded a certain threshold, the entire building would have to meet the standards for new construction, not just the area being improved. This rule was perverse on a number of counts. First, it discouraged needed investment in existing buildings. Second, it mandated a new construction standard for rehabilitation, which was frequently technically problematic, expensive, and unnecessary. For instance, a nonprofit group doing affordable housing rehabilitation in New Jersey was forced to widen a stairway that was 3/4 inch too narrow and to replace windows that were 5/8 inch 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).

The most recent requirements for seismic design in new construction in some parts of the country are a more current example. As a direct result of FEMA efforts under the NEHRP, seismic design is now required in regions of the country that previously ignored such requirements. Although the NEHRP recognizes regions of differing seismicity, when building on certain types of soil in Maryland, the requirements may preclude the use of flat plate concrete construction—commonly used for many years in multifamily 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 question their reasonableness and cost.

Other instances of questionable requirements exist. Four-story, combustible buildings in New York City are cost efficient for housing, commerce, and mixed uses; are permitted as Type III construction under the IBC; and were once quite typical in this urban area. Despite these advantages and history, the current New York City code prohibits building such structures.[2]

### *Restrict Cost-Saving Materials and Technologies*

While residential construction may be a relatively low-tech industry, constant advances have been made in cost-saving materials and technologies. In the 1960s and 1970s, these advances included the use of plastic pipe, preassembled plumbing, and prefabricated metal chimneys, as well as the installation of bathroom ducts instead of windows (U.S. National Commission on Urban Problems, 1969).

Current cost-saving examples include use of precast foundation walls, wood/plastic composite exterior trim/molding, fiber cement exterior trim materials, and laminate flooring (Koebel et al., 2003). Despite the potential cost savings of these innovative materials and procedures, some local building codes at one time prohibited their use. To a certain extent, the building code approval process may simply lag behind 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 plumbers’ charges.

On the other hand, some would argue that recent cost-saving systems, such as Exterior Insulation and Finish Systems, 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. Field and Ventre made the following observation:

> 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 (Field and Ventre, 1971: 147).

For example, manufactured housing units provide an opportunity for affordable housing: because of economy of scale, a 2,000-square-foot manufactured home costs only 61 percent as much as a comparable site-built home (Apgar et al., 2002). In the late 1990s, the two largest manufactured home producers each built 60,000 homes (NAHB Research Center, Inc., 1998). Such production would not have been possible under different building code standards for manufactured homes in different states and localities—the situation that existed before the HUD-Code was promulgated in 1976. A late 1960s survey revealed that diverse local building codes presented the primary obstacle to home manufacturers (U.S. National Commission on Urban Problems, 1969).

Conventional construction also can be affected by multiple building codes. For instance, multiple building regulations and other code characteristics, such as arcane code language, can increase the learning curve for builders and professionals (for example, architects) to familiarize themselves with the building regulations governing a given area. This difficulty may limit competition among developers and professionals working in a given location, and increase construction costs. While this "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 multifamily construction typically does not require advanced engineering analyses, which can be costly. That situation can change, however, 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 comprehending and using the regulations will take more professional time. Arcane and poorly organized text also increases the likelihood of uneven interpretation by inspectors.

## Administrative Impediments

Another article in this volume considers administrative barriers related to building codes; therefore, this article presents only an overview of potential administrative challenges.

### *Skill Inadequacies*

Code personnel may not be adequately trained for their often technically demanding jobs. Insufficient experience may also 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 staff and back-office staff of the same code-administering unit may disagree. The potential for disagreement is even greater among staff of different departments charged with code oversight, such as building departments and 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 (for example, 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 taint building code administration. Sadly, bribery is a recurring scourge in building code enforcement, adding to costs and sapping the integrity of the system.

## Summary of Theoretical Impacts

The numerous substantive and administrative building code impediments described above can frustrate residential development and add to housing costs. We assume 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 impediments constitute the direct impacts of building codes on housing; but building codes may also trigger further indirect and simultaneous consequences. As argued by Noam (1983), if building codes increase the cost of new housing, then it stands to reason that codes may lead to a rise in prices of existing housing because of the positive cross-elasticity of demand between new and existing housing.

At the same time, building codes may increase housing prices, and areas with the highest housing prices may opt for the most restrictive codes to maintain their cachet and exclude the poor. Noam (1983) examines this simultaneous influence of building codes, which is noted in a different context (zoning and land costs) by Glaeser and Gyourko (2003).[3]

The extant literature on the subject discusses many aspects of the above theoretical description of the ways in which building codes affect housing.

## Summary of the Literature

This section provides an overview of 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 codes' impact on rehabilitation. Following this overview, this article examines the extant literature.

### Literature on Building Codes and New Construction

Oster and Quigley provide the following overview of some of the earliest studies:

> 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) (Oster and Quigley, 1977: 364).

The U.S. National Commission on Urban Problems (1969)—often referred to as the Douglas Commission—conducted one of the most comprehensive building code studies. 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 (for example, the marketing of mobile homes), prevent large-scale conventional construction, and are questionably administered.

The Douglas Commission based its findings 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 (for example, 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. The Commission's analysis concluded that these excessive requirements—over and above the model code and other benchmarks, such as the standards contained in the Federal Housing Administration's Minimum Property Standards—could potentially add $1,838, or 13 percent, to the price of a basic home (then estimated at $12,000) (U.S. National Commission on Urban Problems, 1969).

Field and Ventre (1971) surveyed building codes and their administration in 1,100 communities in the United States for the International City Management Association. They developed a local building code "prohibition score" based on the prohibition of 14 construction materials and procedures earlier identified by the Douglas 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 Douglas Commission survey. Nonetheless, many communities surveyed by Field and Ventre, even those nominally under an enlightened model code framework, still resisted cost-saving materials and procedures—echoing the Douglas Commission's findings. Field and Ventre concluded that the building code had a "disastrous impact…on the efficiency of the construction industry" (Field and Ventre, 1971: 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 code's substantive basis (the authors assumed that construction costs would be less expensive in jurisdictions nominally governed by a model code), as well as the code's timeliness (the authors assumed that more recently adopted building codes would be more likely to allow cost savings).

Muth and Wetzler studied, via multiple regression analyses, the relationship of the price of new single-family houses to the characteristics of these houses (for example, 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 single-family housing. Regarding the building code, Muth and Wetzler concluded "the effect of constraints upon the costs of one-family houses is so 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 only by 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. The author found that for a $50,000 single-family home (as an example), the following excess costs from government regulations amounted to $9,844, or about 20 percent of the total cost:

| | |
|---|---|
| Development stage[4] | $5,115 |
| Construction stage[5] | $4,129 |
| Occupancy stage[6] | $600 |
| Total | $9,844 |

Of that total, excessive costs related to restrictive building codes were estimated at about $1,000, or roughly 1 percent of the total cost of the house. Seidel's study of the building code contribution to excessive cost included a survey of whether localities prohibited innovations typically allowed by model codes (for example, plastic pipe) or required "nice but not necessary" provisions (for example, ground fault interrupters). His work paralleled earlier research done by the Douglas Commission (U.S. National Commission on Urban Problems, 1969) and Field and Ventre (1971). Just as previous researchers had discovered, Seidel found that even jurisdictions nominally following national or state building codes often had excessive standards.

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

$$V = f(R, X_1)$$

where *R*, is a continuous variable measuring strictness (that is, 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 to keep housing prices high and exclude the poor. In other words, a simultaneous relationship between housing prices and a restrictive building code might exist.

Using multiple regressions, 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 (that is, areas with high-priced housing are more likely to adopt restrictive housing codes, thus maintaining their exclusiveness), as well as by the strength of labor unions (that is, 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, which noted the following:

> 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 (McKenna, 1982: 216–217).

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 the following:

> 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 (Advisory Commission on Regulatory Barriers, 1991: 3–6).

The Advisory Commission's 1991 study—*"Not in My Back Yard": Removing Barriers to Affordable Housing*, known as the "NIMBY report"—did not put a price tag on the many regulatory barriers to affordable housing (Advisory Commission on Regulatory Barriers to Affordable Housing, 1991). One of its prominent members, however, later suggested that the cumulative cost increase from building codes and many other barriers could be as high as 50 percent (Downs, 1991).

The NIMBY report evoked considerable interest in regulatory barriers. The consolidated plans[7] of numerous states (for example, 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 local community case-study reports on housing costs and regulatory barriers in Colorado (Colorado Department of Local Affairs, 1998), Minnesota, (State of Minnesota, Office of the Legislative Auditor, 2001), Massachusetts (Commonwealth of Massachusetts, 2000; 2002), New York City (Salama, Schill, and Stark, 1999), and Boston (Euchner, 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.[8] Minnesota building code issues included alleged "excessive" requirements (for example, regarding energy conservation and sprinklers in certain apartment buildings), administrative issues (for example, inconsistent local interpretation), and fees in excess of the costs to administer the codes (State of Minnesota, Office of the Legislative Auditor, 2001). Excerpts from other state and local studies regarding building codes and new housing construction are reported in Exhibit 6.

## Exhibit 6

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, 1999: 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, 2003: vii). |
| Colorado | Housing costs could be reduced via the following code changes: modifying requirements for materials and construction, modifying quality standards (for example, allow single room occupancies, and develop rehabilitation sensitive codes (Colorado Department of Local Affairs, 1998). |
| Oregon | "Building codes have been criticized for:<br>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 benefit-cost 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 (for example, 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). |

## Literature on Building Codes and Rehabilitation

Numerous investigations also considered code impacts on rehabilitation.

The U.S. National Commission on Urban Problems (1969) criticized new-construction-based building code standards as being unsuitable for housing renovation. In 1977 and 1978, Metz (Metz, 1977; Metz et al., 1978) 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 *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 *Rehabilitation Guidelines* that covered both administrative and technical subjects in the early 1980s (National Institute of Building Sciences, 1981a, 1981b, 1981c).[9]

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 and Hopkins, 1988) recommended greater flexibility in building code requirements, because the requirements often make rehabilitation more expensive than demolition and new construction. The 1989 report *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 feared liability; and building code restrictions that increased construction costs. The Commission's report reached the following conclusion:

> 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 (Advisory Commission on Regulatory Barriers, 1991: 6).

Studies on regulatory barriers performed after the Advisory Commission report often referenced 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 or comprehensive plans of Connecticut (State of Connecticut, 2000); Colorado (State of Colorado, 2000); Massachusetts (Commonwealth of Massachusetts, 2000) Tampa, Florida (City of Tampa, 1998); Knoxville, Tennessee (City of Knoxville, 2000); and San Antonio, Texas (City of San Antonio, 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 deemed a barrier because of conflict in administration between fire, building, and other departments, and added requirements related to seismic and sprinklers (Euchner, 2003. Commonwealth of Massachusetts, 2000, 2002).

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 at Urbana-Champaign, 1998). This survey also found lingering field-level application of the 25–50 percent rule and "change-of-use rules"—even though the model codes had done away with or significantly moderated these archaic principles.

As noted, the 1990s witnessed efforts to adopt "smart codes," driven by supporting studies demonstrating that traditional, or "unsmart," building codes could add to costs. A number of case studies in Trenton, New Jersey, before the adoption of a smart code found that questionable code administration and unreasonable improvement requirements 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). A spurt of rehabilitation activity in New Jersey occurred, from $176 million in 1996 and $179 million in 1997 to $287 million in 1999; part of that increase was attributed to the code reform and the potential savings it allowed (Forest, 1999). For example, the rehabilitation and adaptive reuse of a building in Jersey City 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).

Many studies found similar results. The National Association of Home Builders Research Center (NAHB Research Center, Inc., 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 (that is, flexible/reasonable application of regulations). This detailed analysis has not yet been released, but it concludes 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 not cited, for instance, numerous brief, anecdotal reports of how building codes supposedly influence housing costs. For example, an interview conducted by Babcock and Bosselman (1973) reports 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 an increase in housing costs in Chicago to the city's antiquated building code (*Chicago Tribune,* 1999).

While disparate in type and quantitative rigor, the literature on the subject of building codes and new housing costs has claimed that codes increase the cost of new housing from roughly 1 percent to more than 200 percent. The more quantitative studies such as Maisel (1953), Muth and Wetzler (1976), and Noam (1983) find code-related housing cost increases of 5 percent or less.

Only a few reports have attempted to quantify the impact of building codes on 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, 2001). Some report a much lower "moderate effect" (Burby, Salvesen, and Creed, 2003).

Because some of the literature examined the impact of an array of regulations on housing cost, we can report on the relative effect of building codes compared to other requirements. Seidel (1978) 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 below zoning and impact fee requirements as barriers (State of Minnesota, Office of the Legislative Auditor, 2001: 27–28).

## Analysis of and Gaps in the Literature

In analyzing the literature, we consider such characteristics as *timeliness*, *conceptual basis*, *methodology*, and *scope*.

### *Timeliness*

*Timeliness* refers to how current the literature is.

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 U.S. National Commission on Urban Problems (1969). Field and Ventre (1971) and Noam (1983) are based on the code world of two generations ago. While we can still learn from this literature in terms of conceptual framework and methodology, their findings 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, Inc. (1999); Listokin and Listokin (2001); and Forest (1999). The rehabilitation code, however, is only one component of the larger subject of building codes and housing costs. We suffer from a lack of research on this larger dimension, specifically studies considering how codes affect new construction.

### *Conceptual Basis*

The *conceptual basis* addresses the benchmark standard of code regulation and administration (the top left quadrant of Exhibit 5), above which regulation is considered inappropriate and, therefore, contributing to excess housing costs. In developing this benchmark standard, studies ideally would conduct an analysis of the costs of various potential building code regulations, as well as the benefits ensuing from these regulations.

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

Numerous studies do not consider the issue of a baseline standard (such as Babcock and Bosselman, 1973; *Chicago Tribune*, 1999) or implicitly refer back to one of the model codes as the standard against which local building code requirements should be judged (such as President's Commission, 1982; Advisory Commission, 1991). Other studies explicitly refer to the model codes as their baseline (such as Muth and Wetzler, 1976) or develop a list of building innovations, which themselves are often model-code-based, for testing their acceptance at the local level (such as U.S. National Commission on Urban Problems, 1969; Field and Ventre, 1971; Seidel, 1978; and Noam, 1983).

Given the comprehensive consensus basis leading to the adoption of model codes, as well as the technical expertise and experience of the entities participating in the development process, turning to the model codes as a benchmark is reasonable. As Muth and Wetzler argue, "construction should be less expensive under less restrictive building codes (presumably under any of the four 'national' codes)" (1976: 60). 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.[10]

Others, however, 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:

> 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 (Colwell and Kau, 1982: 77).

Developing a building code benchmark from a list of innovative practices or perceived excessive requirements presents another challenge. This list is subject to changing priorities and perspectives. For example, Seidel (1978) 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 the building code benchmark would consist of review of requirements, which inevitably have costs, analyzed against their benefits.

Some studies have addressed this subject. A 1978 report by the National Bureau of Standards 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 (McConnaughey, 1978). 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 et al., (1999) conducted a more recent cost-benefit investigation. This study found that building codes that increase housing costs have societal implications from "income effects" (that is, households that purchase a new home have less income remaining for spending on other goods that contribute to health and safety) and "stock effects" (that is, 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 (for example, a $150 expense, or 0.1 percent of the average cost to build a single-family home) would induce offsetting risks yielding between 2 and 60 premature fatalities or, including morbidity effects, between 20 and 800 lost quality-adjusted life years (Hammit et al., 1999).

The two studies cited above illustrate the type of cost-benefit analysis that would inform determination of the benchmark for building code requirements. A study would have to further determine if, say, the GFCI cost-benefit of roughly $3 million per life saved warranted the universal requirement of GFCIs. As we can see from Exhibit 7, however, studies rarely conduct cost-benefit analyses.

## Exhibit 7

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 | | | | NS | No | X | No |
| President's Commission (1982) | X | | | | Model?* | No | X | Limited |
| Advisory Commission (1991) | X | | | | Model? | No | X | Limited |
| Comprehensive Plans (1990s–2000s) | X | | | | NS | No | X | Limited |
| Commonwealth of Massachusetts (2000, 2002) | | X | | | Model? | No | X | Extensive |
| Salama, Schill, and Stark (1999) | | X | | | Model? | No | X | Moderate |
| Euchner (2003) | | X | | | Model? | No | X | Extensive |
| Douglas (1968) | | | X | | Model-Other | No | X | Moderate |
| Field and Ventre (1971) | | | X | | Model-Other | No | X | Moderate |
| Seidel (1978) | | | X | | Model-Other | No | X | Moderate |
| University of Illinois (1998) | | | X | | Model | No | X | Extensive |
| Muth and Wetzler (1976) | | | | X | Model | No | X | Limited |
| Noam (1983) | | | | X | Model-Other | No | X | Limited |
| Burby, Salvesen, and Creed (2003) | | | | X | Model-Other | No | X | Extensive |

A = anecdotal.
CS = case study.
SU = survey.
ST = statistical.
NS = not specified.
* Presumes benchmark standard is a model code; however, this linkage was not specified in the study's text.

### *Methodology*

*Methodology* can include various qualitative approaches, such as gathering testimony from builders and other informed parties (an anecdotal, impressionistic approach) or conducting focused, indepth case studies related to the building code (for example, 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. For example, structured surveys of builders or building inspectors could be conducted. Another example is statistical analysis drawing on the survey data or considering other subjects (for example, are local restrictions significantly linked with higher local housing costs?).

While these methods inform the association between building codes and housing costs, ideally the more rigorous quantitative study would be emphasized. In fact, the opposite is the case (see Exhibit 7). Much of the literature, including some of the most widely quoted reports, such as the Advisory Commission study, rely on qualitative and often anecdotal evidence (Hartman, 1991). Only a handful of statistical regression analyses of how housing codes affect costs (Muth and Wetzler, 1976; Noam, 1983) have been done, and these studies are now quite dated. Much more recent statistical analysis has been accomplished on other regulatory barriers such as zoning and impact fees.

### *Scope*

*Scope* encompasses many considerations, such as the studies' comprehensiveness in considering the extant literature (and relating their findings to that literature), studying building codes in context with other regulations, and examining both the substantive and administrative aspects of the building requirements.

Our review considers only the last characteristic of scope. We believe that considering the administration of the building code to be particularly important (Burby, May, and Paterson 1998).[11] Yet, this ideal of holistically examining both the substance and administration of the code is more often the exception. While many investigations do touch on some aspects of building code administration, the research is typically of a limited, anecdotal fashion as opposed to a more empirical, in-depth study (for example, the 1998 University of Illinois survey of building code enforcement).

In sum, the following gaps are found in the extant literature:

- *Timeliness.* Much research is dated.
- *Conceptual basis.* Limited benchmark and cost-benefit study has been done to define appropriate and inappropriate or excessive regulations.
- *Methodology.* More quantitative investigation is needed.
- *Scope.* More wide-ranging analysis is needed.

Our suggestions for future research 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 discussed earlier, the model building codes have shifted from three (formerly four) regional-oriented codes to two national codes promulgated by the International Code Council and National Fire Protection Association. 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 moving from the old to the new codes.

Exhibits 8 and 9 start these lines of inquiry. Exhibit 8 focuses on how new construction is regulated by the International Building Code 2003 and the NFPA 5000, 2003 edition. Exhibit 9 considers how rehabilitation is regulated by the IBC (Chapter 34 and International Existing Building Code), NFPA (Chapter 15), as well as smart codes developed by New Jersey (Rehabilitation Subcode) and HUD (Nationally Applicable Recommended Rehabilitation Provisions). (Interrelationships exist between the above, such as the NFPA's Chapter 15 being based on the NARRP and Maryland's smart code.) In addition to comparing the respective regulations, both the new construction and rehabilitation exhibits contain a column briefly noting potential cost implications. In brief, the following national requirements may result in significant cost increases in new construction when compared to the earlier regional-oriented model codes:

- Increased sprinkler requirements in multifamily housing in both IBC ([F] 903.2.7) and NFPA 5000 (25.3.5) in comparison to earlier model codes. Potential added cost impact could also result from the NFPA 5000 sprinkler requirement for townhouses, which in some cases may be considered as apartment buildings under that code.
- Introduction in both IBC (1609.1.4) and NFPA 5000 (35.9) of glazed opening impact requirements in hurricane regions, which existed previously only in southern Florida and along the coast of Texas.
- Increased seismic requirements in IBC (1613–1621) and NFPA 5000 (35.10) that affect regions of moderate seismicity.
- Increased live loads on sloped roofs affecting multifamily housing (IBC 1607.11, NFPA 5000 35.7).
- Increased complexity of structural design, primarily because of structural load standards, which may have more impact for NFPA 5000 in its effect on wood frame construction than for IBC.

The following national requirement may result in significant 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, Chapter 15—is subject to further study. New Jersey and NARRP may have the greatest impact on cost reduction, while IEBC may have less impact than NFPA.

The following requirements may result in significant cost impacts from differences *between* the current national codes:

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

Further empirical research, as described below, is needed to understand better the potential cost impacts cited above.

## Exhibit 8

Analysis of Contemporary National Model Building Code Regulation of New Construction

| Provisions | International Building Code (IBC) 2003 | National Fire Protection Association (NFPA) 5000, 2003 Edition | Cost Impacts |
|---|---|---|---|
| **Applicability** | New buildings in all occupancies. Detached one- and two-family dwellings and townhouses referred to the International Residential Code (IRC). | New buildings in all occupancies. | |
| **Fire and life safety** | Expansion of requirements for sprinklers, especially in residential construction. Sprinklers required in all residential occupancies except those designed to the IRC (one- and two-family dwellings and townhouses). | Expansion of requirements for sprinklers, especially in residential construction. Sprinklers required 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 American Society of Civil Engineers (ASCE) 7. They are evolving and becoming more complex, while increasing in some respects and decreasing in others. A 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. A 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 National Earthquake Hazards Reduction Program 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. |
| **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 pounds per square foot.) | Live load on sloped roofs increased significantly. | For both, significant added cost in multifamily housing compared to earlier codes. |

**Exhibit 8 (continued)**

Analysis of Contemporary National Model Building Code Regulation of New Construction

| Provisions | International Building Code (IBC) 2003 | National Fire Protection Association (NFPA) 5000, 2003 Edition | Cost Impacts |
|---|---|---|---|
| **Materials** | References to consensus standards. | References to consensus standards. | |
| **Accessibility** | Dwelling units must comply with American National Standards Institute (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 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (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. |
| **Single-room occupancies** | 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. |
| **One- and two-family housing and town-houses** | Reference to 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 one- and two-family only; townhouses must be engineered and cannot use conventional construction, but this depends on interpretation. Cost impact of new seismic requirements (ASCE 7) still unknown. | Potentially greater cost impact of NFPA in case of townhouses. |

**Exhibit 8 (continued)**

Analysis of Contemporary National Model Building Code Regulation of New Construction

| Provisions | International Building Code (IBC) 2003 | National Fire Protection Association (NFPA) 5000, 2003 Edition | Cost Impacts |
|---|---|---|---|
| **Modular** | Treated like site-built, except for acceptance of offsite inspection in the enforcement. | Treated like site-built, except for acceptance of offsite 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. |

## Exhibit 9

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

| | NJ 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 and 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 three categories, as a function of the extent and nature of the work:<br>• Renovation.<br>• Alteration.<br>• Reconstruction.<br>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 three categories, as a function of the extent and nature of the work:<br>• Renovation.<br>• Alteration.<br>• Reconstruction.<br>Requirements increase respectively.<br>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, which 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 memberor fire resistance. | Alterations divided into three categories, as a function of the extent and nature of the work (similar, but not identical, to NARRP):<br>• Alterations Level 1.<br>• Alterations Level 2.<br>• Alterations Level 3.<br>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 three categories, as a function of the extent and nature of the work:<br>• Renovation.<br>• Modification.<br>• Reconstruction.<br>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.<br>All but NJ and NARRP apply FEMA's "substantial improvement" trigger, and will have significant cost impact in the flood plain.<br>IEBC has extensive cost impact from its structural damage repair requirements.<br>Some argue the order of growing cost impact as follows:<br>1. NJ.<br>2. NARRP.<br>3. NFPA 5000.<br>4. IEBC. |

**Exhibit 9 (continued)**

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

| | NJ Rehabilitation Subcode | NARRP 1997 | IBC Ch. 34 2003 | IEBC 2003 | NFPA 5000 Ch. 15 2000 | Cost Impacts |
|---|---|---|---|---|---|---|
| **Regulations governing additions** | Additions must conform to new construction requirements and not create or extend a nonconformity. Existing building plus addition to comply with height and area requirements, with up to an additional 25% for one- and two-story buildings. | Additions must conform to new construction requirements and not create or extend a nonconformity. Existing building plus addition to comply with height and areas requirement, with up to an additional 25% for one- and two-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 height and area requirements. | Additions must conform to new construction requirements and not create or extend a nonconformity. Existing building plus addition to comply with height and area requirements. | Additions must conform to new construction requirements and not create or extend a nonconformity. Existing building plus addition to comply with height and area requirements. | All are essentially the same, except that NJ and NARRP allow up to a 25% increase in allowable area for one- and two-story buildings. |
| **Regulations governing change of use** | Use groups categorized into six hazard category tables. Compliance with selective requirements based on specific increases in hazards. Minimal requirements when hazards are 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 four hazard category tables (including seismic). Compliance with selective new construction requirements based on specific increases in hazards. Minimal requirements when hazards are 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 new construction requirements for the new occupancy. The building official may accept less, provided the new use is less hazardous "based on life and fire risk." | Use groups categorized category tables (not including seismic). Compliance with selective new construction requirements based on specific increases in hazards. Minimal requirements when hazards are 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 three hazard category tables (not including seismic). Compliance with selective new construction requirements based on specific increases in hazards. Minimal requirements when hazards are 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. |

**Exhibit 9 (continued)**

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

| | NJ Rehabilitation Subcode | NARRP 1997 | IBC Ch. 34 2003 | IEBC 2003 | NFPA 5000 Ch. 15 2000 | Cost Impacts |
|---|---|---|---|---|---|---|
| **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 4310 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, and NFPA allow for “infeasibility” alternatives. |
| **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 NJ, but recognizes currently existing fire code, housing code, and other retroactive regulations. | Not in scope of 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 Ch. 15 requires building to be legally existing. | All are essentially the same. None are retroactive, but they recognized locally adopted retroactive requirements. |

NARRP = Nationally Applicable Recommended Rehabilitation Provisions.
IEBC = International Existing Building Code.
IBC = International Building Code.
NFPA = National Fire Protection Agency.

### *New Construction-Related Research*

*Identification and analysis of the impact of the latest seismic provisions on housing.* Compare costs of new and older (for example, 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 the 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 and shutter manufacturers, curtain wall consultants, and architects knowledgeable in the field of impact of windborne debris, and experienced in building design in the aforementioned regions.

*Identification and analysis of the impact of the latest sprinkler requirements in multifamily housing.* Compare the costs of new and older sprinkler requirements in the three regions (West, South, and Midwest/East Coast) 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 multifamily housing configurations.

*Identification and analysis of the impact of different plumbing codes.* Compare 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 the 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 by identifying locations where rehabilitation codes have been adopted and enforced for at least 2 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 (for example, NAHB/Research Center 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 Federal Emergency Management Administration National Flood Insurance Program criteria on the rehabilitation of low and moderate cost housing.* Survey and analyze the impact of the FEMA National Flood Insurance Program (NFIP) criteria on substantial improvement, which have found their way into both the IEBC and NFPA 5000's Chapter 15, on the rehabilitation of housing in the floodplain.

This research will begin with a survey of a representative sample of local jurisdictions located in floodplains. Jurisdictions that participate in the FEMA NFIP 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 floodplain, 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 NIFP. If the survey confirms the existence of this problem, its extent will be quantified through an indepth study. Recommended changes to the FEMA criteria, or at least to the way they are mandated in the building codes and rehabilitation codes (for example, 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

Admittedly, establishing consensus on the benchmark for appropriate building code standards and administration is difficult, but more work must be done in this area.

One possibility is simply to compile a list of innovative building materials and procedures, and then examine if communities accept or reject the listed items. This method was used successfully by the U.S. National Commission of Urban Problems (1969), Field and Ventre (1971), and Seidel (1978); we need a contemporary version. The list of today's innovations could draw on the cutting-edge building materials and practices already identified by Koebel et al. (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). Although the JVAH dates from the 1980s (National Association of Home Builders, 1982a, 1982b), 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 U.S. National Commission on Urban Problems (1969) 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. We can agree that the most affordable types of shelter consist of reinventing the single room occupancy (SRO) dwelling (Downs, 1991) and allowing accessory housing, such as granny flats or other affordable configurations (for example, the Boston triple decker or a four-story combustible building in New York City). If and how the building codes restrict production of these affordable units should also be analyzed.

The identification of benchmark standards for building codes, however accomplished, would benefit from cost-benefit study. Only a cost-benefit comparison can determine if the new national code requirements for seismic design, hurricane region impact protection, and sprinklers are appropriate.

Other observers similarly call for cost-benefit study of the building code. After considering more stringent proposed seismic standards in the New Madrid seismic zone,[12] Stein and Tomasello argued that

> over its 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 (2004: A13).

We acknowledge the challenges to such benefit-cost investigations.[13] Who receives the benefits is not clear. Data are limited (for example, the insurance industry guards relevant incidence and loss information). Researchers are confronted with a host of methodological and calculation issues (for example, costs and benefits occur at different points in time, raising issues of life-cycle analysis). In many cases, the benefits are probabilistic (for example, the benefits of reduced earthquake losses will not be realized if the earthquake does not occur). Still, the groundwork for cost-benefit study has been established (McConnaughey, 1978).

This type of investigation can benefit from data and models developed for other purposes. For example, FEMA has developed a Natural Hazard Loss Estimation Methodology (HAZUS) risk assessment software program that estimates losses from natural disasters, such as earthquakes, floods, and storms. Perhaps, HAZUS could be used in a cost-benefit study on the new national building code requirements regarding seismic design and wind-borne debris impact protection.

The following are examples of such research:

1. Life-cycle cost-benefit analysis of natural disaster mitigation provisions in International Codes and NFPA 5000:

    - Develop a life-cycle benefit-cost 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 the Applied Economics Division of the National Institute of Standards and Technology's Building and Fire Research Laboratory, and the standard models developed by them at the American Society for Testing and Materials (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, use this software in regions where seismic data and building inventory data are recognized as being reliable.

    This research will require a variety of assumptions. Because 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

We need more empirical data on the subject, as well as quantitative analysis on how codes affect housing.

For example, contemporary information is needed on the local implementation of building regulations, including whether a local jurisdiction has a code, the basis of that code, the profile of officials implementing the regulations (for example, background, education, and civil service status), as well as other details (for example, prohibited and permitted materials and procedures). The last national comparable survey of that type dates from the late 1960s to the early 1970s (U.S. National Commission on Urban Problems, 1969; Field and Ventre, 1971), and clearly a contemporary equivalent database is needed.

With such data, we can perform a quantitative analysis of how building regulations and their administration affect housing. In essence, we can revisit, with current data, the Noam (1983) regression study. Researchers also might tap existing data to analyze how codes influence housing. For example, Insurance Services Office, Inc. (ISO) has developed a Building Code Effectiveness Grading Schedule (BCEGS) for most communities in the United States. The BCEGS assesses the substantive basis of the building codes in a particular community (for example, are codes based on a current edition of a model code?), as well as how well a community enforces its building codes (for example, code official qualifications, training, and staffing levels). The BCEGS uses 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. In this model 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 (for example, 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, communities with lower (that is, better) BCEGS rankings should be characterized by lower housing costs.

The above approach is not without its drawbacks. ISO has thus far only released the distribution of BCEGS rankings on a statewide basis. 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 (that is, reduce) the BCEGS score? 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

We also need a broader scope of research on building codes and housing. More attention needs to be paid to both the substance and the administration of the code. The latter, unfortunately, has often been shortchanged. For instance, the New Jersey rehabilitation subcode and the NARRP share many similarities (see Exhibit 9). 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 (for example, 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, first using 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 hard to come by; however, certain potential sources should be explored. As noted, the BCEGS ranking covers numerous administrative characteristics. The multiyear research by the National Conference of States on Building Codes and Standards regarding regulatory streamlining may be another asset for researching code administration. In addition, future research on the topic of code administration would be well served by considering the work by Burby, Salvesen, and Creed (2003), Burby et al. (2000), and Burby, May, and Paterson (1998) 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 presume that if a cost-saving material or procedure is available, it will be used—but for code restrictions. The literature on diffusion of innovation 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, 1977; Koebel et al., 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 remains in use. Because Davis-Bacon requirements (mandating that prevailing wages be paid on certain HUD-funded projects) for subsidized housing increase labor costs, this federal mandate may inadvertently push more subsidized rehabilitations to comply with more stringent requirements. Further, according to Listokin and Listokin (2001), 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 funds (Listokin and Listokin, 2001). The inspectors favored a strict interpretation of the housing code because they felt that with a HUD subsidy, "the money is then available and the job can be done right" (Listokin and Listokin, 2001: 93). Thus, the very fact that housing is subsidized may exacerbate code problems.

As is evident from the above discussion, many overdue and fruitful areas exist for studying how building codes affect housing costs. As researchers, we remain true to our calling by recommending more research. At the same time, perspective is needed. 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 than building codes with respect to new construction. (This 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, building codes constitute a high, but not the highest, priority for regulatory study.

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## Authors

*David Listokin is Co-Director of the Center for Urban Policy Research at Rutgers University and is a professor at Rutgers' Edward J. Bloustein School of Planning and Public Policy. Dr. Listokin has authored numerous studies on housing, land use, and public finance.*

*David B. Hattis is one of the founders and is President of Building Technology Inc. (BTI). His work at BTI includes projects related to the building regulatory system; performance analysis of buildings, both new and existing; the economic and financial implications of decisions related to building performance on a life-cycle basis; and the study and use of historic properties. Mr. Hattis has authored numerous reports and delivered technical papers on these subjects. He is a recognized expert in the field of building performance and regulation.*


## Notes

1. Includes states with regulations governing any structure, including government buildings.

2. Michael Schill, 2004, letter to author, February 16.

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

4. Impacts from zoning ordinances, environmental controls, growth controls, and subdivision regulations.

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

6. Impacts from settlement practices and regulations.

7. Consolidated plans must be filed by the state and localities to receive federal funding for housing and community developments. The consolidated plans include a section of "governmental constraints."

8. Although 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).

9. This was part of a broader effort at regulatory reform; see National Association of Home Builders (1976, 1982a) and Weitz (1982).

10. 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" (Fed. Reg., 66291, Nov. 25, 2003).

11. 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 (for example, granting a variance) is so vital to the process.

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

13. 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 and/or Memphis, and cause extreme economic disruption to the nation.

    In recent years, earthquake risk has been better understood, which 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 cost-benefit ratios for new construction in both Los Angeles and Memphis for all building types examined. The cost-benefit ratios for rehabilitation in Memphis were more ambiguous, depending on building type, structural materials, and whether and how deaths and injuries were to be accounted for in the analysis.

    At about the same time, FEMA developed a cost-benefit model for seismic rehabilitation and published four reports, two on commercial applications and two for federal applications. In a case study of a Veterans Administration hospital in Memphis, the cost-benefit ratio of rehabilitation was less than 1.0 for property damage. When adding the benefits of deaths and injuries avoided, the cost-benefit ratio became significantly larger than 1.0.

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