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Benefits and Costs of Increasing Housing Production in Massachusetts

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Prepared by
Kimberly Burnett
Bulbul Kaul
Abt Associates Inc.
Cambridge, MA

Abt

Abt Associates Inc.

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This report is the second in a series of three commissioned by the Massachusetts Housing Partnership's *Foundation for Growth* initiative. The first report, by the UMass Donahue Institute,[1] identified housing production benchmarks that would result in optimal economic benefits for the state. The production benchmarks analysis identified the need for over 340,000 new units of housing by 2020 to achieve a stronger-growth scenario that results in stronger employment growth in the Commonwealth. Without these new units, the UMass Donahue Institute projects that current economic trends will hold, and employment growth will significantly lag the national economic growth rate between 2010 and 2020.

This report builds on the UMass Donahue Institute paper, using the scenarios and projections they developed to measure the benefits and costs to Massachusetts associated with achieving the stronger-growth scenario's level of housing production. The third report in the series (being done by the Dukakis Center at Northeastern University) will identify potential strategies for achieving the housing benchmarks set by the UMass Donahue Institute.

We project that increasing housing production produces large net benefits for the state as a whole: more than $19.5 billion. In addition, 296,559 new jobs are added. However, the benefits are sensitive to assumptions about the timing of housing production and job creation, and to assumptions about the state of the economy in the absence of efforts to increase housing production. Further, although many groups receive benefits from housing productions, the costs are primarily borne by local communities who are obligated to provide services to new residents.

The two economic scenarios being compared—baseline and stronger-growth—are described next, and then we discuss important assumptions about our evaluation of benefits and costs of housing production. Benefits and costs for the state as a whole are then presented, followed by impacts on specific groups within the state, and then impacts on each of the seven economic benchmark regions in the state. These regions are Berkshire, Cape and Islands, Central, Greater Boston, Northeast, Pioneer Valley, and Southeast.[2] Details of the analysis of benefits and costs of housing production are in the Methodology section, and a sensitivity analysis of each of the major assumptions is in the Appendix.

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[1] Koshgarian, *et al.*, 2010a.

[2] These regions are used in *Mass*Benchmarks, a quarterly economic journal published by the University of Massachusetts in cooperation with the Federal Reserve Bank of Boston.

A Tale of Two Commonwealths

According to analysis conducted by the UMass Donahue Institute, without some intervention in the housing market, current projections are that demand for housing units will outstrip supply by almost 30,000 units by 2020. This **baseline** scenario is the best estimate of what will happen in the absence of any economic, policy, or other intervention. It depicts a state with job and housing development that, while higher than current recession levels, does not keep pace with needs. It also depicts a state where job growth is limited by housing constraints.

In the baseline scenario, the UMass Donahue Institute projects:

- 170,496 new housing units are added from 2010 to 2020
- 87,922 new jobs are added from 2010 to 2020
- 29,926 housing unit shortage in 2020

The **stronger-growth scenario** is a theoretical one that produces a balance between housing market supply and demand by 2020. In addition to making up the projected housing shortage between now and 2020, it also reflects the additional new employment and associated additional housing demand that could be created if a restricted housing supply no longer acts as a constraint on employment growth. The new employment is assumed to be the level that yields a rate of employment growth from 2006-2008 to 2020 that is 75 percent of the U.S. rate of growth over the same period. This is higher than normal for Massachusetts, but not an unrealistic rate of employment growth. It also eliminates the housing shortages that exist in some regions of the state.

In the stronger-growth scenario between 2010 and 2020:

- 340,196 new housing units are added
- 296,559 new jobs are added
- 392,833 additional people, or 149,880 new households are added
- There is no housing shortage or surplus

Benefits and costs evaluated are for the stronger-growth scenario *compared with* the baseline scenario. Benefits and costs of the stronger-growth scenario are "counted" only to the extent that they are different from the baseline scenario. That is, under the stronger-growth scenario, an *additional* 169,699 housing units are produced—almost double the production in the absence of any intervention.

This analysis of benefits and costs does not consider the mechanism or strategy that might be used to induce new housing production, but assumes that it includes permanent changes to the state's regulatory regime that increase the flexibility of the state's housing supply response. Excluding the costs and benefits of the strategy that might be used does not imply that these are not important, only that they are outside the scope of this study.

Timing of Housing Production

The benefits and costs identified in this analysis are heavily dependent on the timing of housing production, job creation, and the growth in population in the state. They are also sensitive to assumptions about the state's unemployment rate in the absence of an intervention to increase housing production. Key benchmarks are shown in Exhibit 1 below.

Exhibit 1. Key Timing Benchmarks

2010-2012	**Strategy development,** including defining a specific proposal to produce additional housing, generating support for the proposal, and lobbying for the necessary legislative changes.
2013-2015	**Strategy implementation.** In each year, housing production increases by 25 percent over the previous year as market actors respond to new incentives. The increased housing production begins to create new jobs, primarily in the construction industry. Some "multiplier effect" jobs are created as well. The housing production also attracts new population to the state, increasing population growth by 25 percent each year over the previous year. By 2015, the state's unemployment rate is assumed to return to normal levels for all but the construction industry in the baseline scenario.
2016-2020	**Full implementation.** The increased housing production reaches full implementation and levels off at an annual rate substantially higher than under the baseline scenario. The housing production also generates permanently higher employment as the housing market, now more flexible, no longer acts as a constraint on employment growth. Population growth levels off but is higher than under the baseline scenario. By 2018, employment in the construction industry is assumed to return to normal levels in the baseline scenario.

In calculating the net present value of costs and benefits, we use a discount rate of 3.5 percent. This is the average 10-year Treasury constant maturity rate for July 2009 through July 2010.

Massachusetts Results

Increasing housing production yields large net benefits for the state as a whole: more than $19.5 billion. As shown in Exhibits 2 and 3, this includes net benefits of $19.0 billion in wages to workers who would otherwise be unemployed, and almost $2.4 billion in state tax revenues. Some of the state tax revenues would likely be offset by about $.5 billion in higher state education spending (Chapter 70) to compensate communities for additional schoolchildren as the population increases. Some costs are imposed on commuters from increases in congestion. The benefits to home buyers from slightly lower house prices are mostly, but not entirely, offset by costs to home sellers. The benefits for renters are not included because the at least partially offsetting losses to landlords could not be calculated, but are described below.

Exhibit 2. Massachusetts Results
Total Net Present Value of Benefits and Costs ($000s)

Short-term Job Creation, Net Wages	$6,460,350
Long-term Job Creation, Net Wages	$12,550,040
State Revenues	$2,376,572
Addtl State Education Spending	$(501,146)
Property Taxes	$887,177
Costs to Communities	$(2,117,848)
Lower House Prices	$198,029
Costs of Congestion	$(37,386)
	$19,815,239

While workers benefit, communities are clearly hurt by new housing production. Although new units generate $887 million in property taxes, these revenues do not offset the $2.1 billion in costs to communities, which include school expenditures, non-school expenses such as fire and police protection, and infrastructure. They incur costs in three major areas:

- **Building infrastructure**, such as a roads, sewers, and government buildings. We estimate that the stock of local government capital is roughly $11,000 per resident. Assuming that additional government capital is required to accommodate new residents, and that the costs of building new infrastructure as population increases are financed using municipal bonds at 4.3 percent, these expenditures require an annual payment of about $485 per person.
- **Educating new schoolchildren.** The influx of students into most communities under the stronger-growth scenario is fairly large, with increases in school enrollment of about 5 percent on average. The minimum community contribution per pupil under the state's education funding laws averages $5,250. At the same time, the state's Chapter 70 aid per pupil averages about $3,910 (an amount we assume the state would continue to contribute), for total school spending per pupil of about $9,160,[3] although this varies widely by community. We use average cost in each region for our calculation of school costs, except in the first year of school enrollment increases, when increases in students in each district are quite small. In this year, we use the marginal cost. We estimate that the *marginal* cost of educating an additional child is about $4,500, compared with the average cost of about $9,160.
- **Providing services** such as government, recreation, fire and police protection, and public works. We estimate the cost per capita of these services (net of fees for services) is

[3] Calculations are based on data from FY 2008, the most recent complete data available.

about $1,000. The marginal cost of services may be lower. For example, communities may be able to accommodate more residents without an increase in fire and police protection, but population increases are large enough on average (roughly 5 percent) that an average cost is probably more appropriate. Excluding the costs of fire and police protection, the cost of providing non-school services is about $650 per capita.

Jobs created as a result of the increased housing production produce benefits in the form of wages to workers as long as the nationwide unemployment rate is projected to be above normal, which we assume to be through 2020. The wages paid to workers after 2020 are entirely offset by their opportunity costs—alternative employment opportunities.

Exhibit 3 shows the Massachusetts results presented by the group of people who are affected. The exhibit again shows that the impact on communities is negative: the housing production costs communities $1.2 billion more than they collect in additional property taxes, even assuming the state subsidizes the cost of educating additional schoolchildren through additional Chapter 70 aid.

Exhibit 3. Benefits and Costs to Specific Groups
Net Present Value ($000s)

Impact on Workers	$19,010,390
Impact on State/Taxpayers	$1,875,426
Impact on Communities	$(1,230,671)
Impact on Homebuyers	$902,663
Impact on Home Sellers	$(704,634)
Impact on Commuters	$(37,386)
	$19,815,789

As stated above, the impact on renters is not included in the overall calculation of benefits and costs of additional housing production. However, it is worth noting that by 2020, additional housing production is projected to save renters more than $1.3 billion.

Alternative Property Tax Assumptions

In the results presented in Exhibits 2 and 3, annual property taxes per unit are assumed to be $2,187, a fairly conservative figure that was estimated by the UMass Donahue Institute team based on property taxes paid in 2006-2008 for ownership and rental units statewide. An alternative assumption is from a study of the actual state and local tax revenues from units built under Chapter

40B from 2000 to April 1010. This study estimates that annual property taxes per unit, which included homeownership and rental units concentrated in Metro Boston, were $2,825 in 2008.[4]

New units built under the stronger-growth scenario are similar to the 40B units in that they are also concentrated in Metro Boston, and will be newly constructed. Assuming that new units built under the stronger-growth scenario generate average annual property taxes of $2,825 instead of $2,187, the total net benefit to the Commonwealth increases to nearly $3.5 billion, and the net impact on communities falls to negative $972 million (see Exhibit 4). Although impacts on communities are still negative, the impact is smaller, and this alternative assumption may be more realistic.

Exhibit 4. Massachusetts Results, Alternative Property Tax Assumptions
Total Net Present Value of Benefits and Costs

	Property Tax Assumption	
	$2,187 per unit	**$2,825 per unit**
Total Property Taxes	$887,177	$1,146,019
Net Impact on Communities ($000s)	$(1,230,671)	$(971,829)
Net Impact on Massachusetts ($000s)	$19,815,789	$20,074,631

Benchmark Region Results

Exhibit 5 shows the state results alongside the impacts of housing production on each of the state's seven benchmark regions using the original property tax assumption of $2,187 per unit. State revenues and additional state spending on education are calculated only at the state level; these costs are not incurred at the benchmark region level. The impact on house prices is also calculated only at the state level using data are not available at the benchmark region level. As shown, these benefits are fairly modest.

The net impact on each region is positive in every region. The **Berkshire** and **Cape and Islands** regions have the smallest impact: $442 million and $729 million, respectively. This is driven by relatively small long-term job creation in these regions.

The **Central** region is projected to have a sizeable surplus of housing under the baseline scenario (roughly 17,000 units), so even with additional job and population growth, fewer total housing units are built under the stronger-growth scenario in this region. As a result, there are fewer construction-related jobs, although this is offset by long-term job creation. Fewer housing units also result in declines in property tax collections.

[4] Koshgarian, *et al.*, 2010b.

On the flip side, there are costs to the projected overbuilding in the Central region that the stronger-growth scenario avoids, such as deterioration of vacant housing stock, downward pressure on rents and housing prices (which benefits homebuyers and renters but hurts homeowners and landlords), and consumption of open space. In addition, the recent experience of Phoenix and Las Vegas highlights the lesson that overbuilding housing does not create a sustainable economy, so the longer-run result of the higher-growth scenario may be a healthier economy. These impacts of the stronger-growth scenario are not quantified however, so full impacts are not clear.

Exhibit 6 shows that in general, workers are the major beneficiaries of additional housing production, because of the jobs created by building, selling, financing, and furnishing homes. Additional jobs result from the "multiplier effect" that occurs when these workers spend money in the local economy. These jobs are created during a time when the economy is expected to be weaker than normal, so workers' opportunity costs are low.

A permanent rise in employment also results from relieving the constraints that currently affect the state's housing supply, such as onerous regulation of residential construction. Housing supply constraints affect the labor market, because labor markets cannot fully respond to increases in labor demand.[5] We assume that these jobs are not created until near the end of the 10-year period. After 2020, we assume that the nation's economy will have returned to normal, so opportunity costs in the form of alternative employment opportunities offset wages paid to workers.

As in the state-level analysis, while workers benefit, communities in every region are clearly hurt by new housing production. Costs to home sellers from slightly lower house price appreciation rates—about 1.3 percent by 2020—are offset by benefits to home buyers. Benefits to home buyers, in fact, slightly exceed costs to home sellers because we assume sellers of newly constructed homes do not experience losses.

Commuters also experience small losses, because of increases in congestion from additional drivers. We assume that new development is relatively high density and close to transportation, so new commuters are slightly more likely to use public transportation than other drivers, and have commutes that are slightly shorter. This helps reduce the impact of new commuters, but other drivers still experience slightly slower travel speeds.

[5] Saks, 2005. The only portion of the state included in the study is the Boston metro area, but we assume the entire state's housing supply is constrained.

Exhibit 5. **Benefits and Costs by Benchmark Region**
Total Net Present Value ($000s)

	State	Berkshire	Cape and Islands	Central	Greater Boston	Northeast	Pioneer Valley	Southeast
Net Wages, Short-term Jobs	$6,460,350	$253,008	$378,921	($413,676)	$4,609,110	$926,425	$483,963	$222,600
Net Wages, Long-term Jobs	$12,550,040	$190,597	$389,330	$1,423,469	$5,993,925	$1,787,194	$1,077,417	$1,688,157
State Revenues	$2,376,572							
Addtl State Education Spending	($501,146)							
Property Taxes	$887,177	$34,289	$47,613	($42,509)	$617,028	$110,914	$80,229	$39,614
Costs to Communities	($2,117,848)	($35,802)	($85,123)	($197,853)	($1,136,914)	($266,036)	($180,160)	($235,847)
Lower House Prices	$198,029							
Costs of Congestion	($37,386)	($526)	($811)	($4,605)	($16,981)	($5,449)	($3,444)	($5,569)
TOTAL	**$19,815,789**	**$441,565**	**$729,930**	**$764,826**	**$10,066,168**	**$2,553,047**	**$1,458,005**	**$1,708,954**

Exhibit 6. **Benefits and Costs to Specific Groups by Benchmark Region**
Total Net Present Value ($000s)

	State	Berkshire	Cape and Islands	Central	Greater Boston	Northeast	Pioneer Valley	Southeast
Impact on Workers	$19,010,390	$443,605	$768,251	$1,009,793	$10,603,035	$2,713,618	$1,561,380	$1,910,757
Impact on State/Taxpayers	$1,875,426							
Impact on Communities	($1,230,671)	($1,514)	($37,510)	($240,362)	($519,886)	($155,122)	($99,931)	($196,234)
Impact on Homebuyers	$902,663							
Impact on Home Sellers	($704,634)							
Impact on Commuters	($37,386)	($526)	($811)	($4,605)	($16,981)	($5,449)	($3,444)	($5,569)
	$19,815,789	**$441,565**	**$729,930**	**$764,826**	**$10,066,168**	**$2,553,047**	**$1,458,005**	**$1,708,954**

Other Impacts

This estimate of the impacts of higher housing production may be conservative for several reasons. For example, if the strategy encourages sustainable housing production, more efficient development patterns could result. Smart growth development—compact development that is close to jobs, urban centers, and transit—could mitigate the loss of open space. As a second example, if the stronger-growth scenario results in both higher levels of employment at relatively high wages, savings on certain state expenditures could result, such as Medicaid and unemployment insurance. These benefits are also not counted.

On the other hand, there may also be costs to higher housing production that are not counted. The most important of these are the costs to the state of additional population. Although costs of additional schoolchildren are accounted for, other costs, such as additional public safety, health, and higher education costs, are not.

Transfers

Several benefits and costs are transfers from one group to another—benefits to one group represent costs to another. These include rent decreases, which benefit renters but represent a cost to existing landlords, and tax payments, which benefit the population of the state or community generally but represent a cost to the taxpayers. As transfers, these costs and benefits "cancel out" and do not produce net benefits in the calculation of societal benefits of housing production. They are important to consider, however, because although there may be no net impact on society, a successful strategy for higher housing production may need to find ways to compensate the "losers" in the equation.

The largest transfer is the $2.4 billion paid by Massachusetts residents to the state in the form of income and sales taxes. This revenue, however, is spent on programs that presumably are of value to state residents,[6] so they receive benefits in exchange for their taxes (as a group).[7] This activity of transferring resources from one group (taxpayers) to another (the state) and back again is not without costs, however. Not all taxes paid to the state can be translated into direct benefits for residents because administrative activities result in some "leaks."

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[6] There is some disagreement over whether this is true for all government programs. The largest programs are Medicaid, which accounts for 33 percent of the state budget; and K-12 Chapter 70 aid, about 12 percent of the state budget. The benefits of high-quality education and health insurance have been clearly demonstrated, regardless of whether one believes government should be involved in these activities. See, for example, Psacharopoulos, 2002; and Franks, *et al.*, 1993.

[7] One of these programs is state aid to communities for K-12 education, Chapter 70 aid, which has been accounted for explicitly.

Even if we were to assume that state programs have *no* benefit and exclude these from the net impact of the higher-growth production scenario entirely (as well as offsetting education costs), then net benefits would still be nearly $18 billion.

The same line of reasoning applies to property taxes collected by communities. These are counted as a benefit to communities and not as a cost to taxpayers because taxpayers receive benefits from the services funded by property taxes – education for children, roads, sewers, public safety, and health and recreation. Residents would also likely pay property taxes regardless of where they live, so the stronger-growth scenario is not the cause of residents' property tax payments.

Methodology

The baseline scenario developed by the UMass Donahue Institute team projects that about 170,000 new units of housing will be built by 2020; the stronger-growth scenario envisions a future where over 340,000 new housing units are added. This is an additional 170,000 housing units—double the production of the baseline scenario. This benefit-cost analysis examines the impact of these additional housing units on the state including its economy, its communities, and its residents.

Housing production will not double without significant policy changes, probably at both the state and local level. This study does not consider the strategy that might be used to induce new housing production, but assumes that it includes permanent changes to the state's regulatory regime that increase the flexibility of the state's housing supply response. Excluding the costs and benefits of the strategy that might be used does not imply that these are not important, only that they are outside the scope of this study. When a strategy is formulated to encourage housing production, its specific costs and benefits will be an important component of the overall analysis of the impacts of housing production in the state.

Stakeholders Affected by Housing Production

Seven major groups of stakeholders may be affected by an increase in housing production between 2010 and 2020. These include workers/job seekers; taxpayers; state residents who currently own a home; state residents who currently rent their housing; landlords; and residents of the communities where new housing production would occur. The potential impact of increased housing production on these groups is summarized in Exhibit 7. As discussed above, transfers – benefits to one group that represent costs to another – are included even though they "cancel out" because although there may be no net impact, a successful strategy may need to find ways to compensate the "losers" in the equation. The approach to estimating potential impacts of housing production on stakeholders is discussed in more detail in the rest of the section.

Exhibit 7. Summary of Potential Benefits and Costs of Housing Production

	Potential Benefits	Potential Costs
Workers/Job Seekers	Job creation	Foregone time for leisure or other non-market activities Foregone unemployment benefits
Taxpayers	State income, sales and excise, and business tax revenue	Taxes or fees for direct spending on strategy to encourage housing production* State income, sales and excise, and business taxes paid
Community	Property tax revenue from new homes constructed	Increases in local school expenditures Impacts on environmental quality—loss of open space,* greenhouse gases from new commuters and energy used to operate new homes Increased congestion/commuting costs Costs of new infrastructure
Current Homeowners	*Greater home price stability (reduced risk of holding housing as an asset)	Lower growth in housing prices for home sellers because of increases in supply
Current Renters	Lower rents because of increased supply in rental market Lower house prices because of increases in supply *Benefits of homeownership for new home buyers (equity accumulation, satisfaction with home and neighborhood, increased neighborhood stability, increased participation in voluntary and political activities)	
Landlords		Lower rental income because of increased supply in rental market

*These are not quantified.

Workers and Job Seekers

Adding units to the Massachusetts housing stock will affect employment levels in the state in two ways: Higher levels of housing construction will create jobs in the construction industry and other supporting sectors, and longer-term job growth is likely to result from a less-constrained housing supply.

Short-run job creation

New housing construction in Massachusetts will create jobs directly related to the production of housing but also jobs in other industries that support the construction industry such as real estate sales and finance. In a healthier economy, we would not necessarily include job creation as a benefit of new housing production. Rather than creating new jobs, the labor required to build the new housing could simply drive up wages of construction workers and others. Given the state's current economic conditions, and the fact that the construction industry has been particularly affected by the current recession, we assume that additional housing production will create jobs, at least temporarily, for currently unemployed construction workers (Exhibit 8).

Exhibit 8. Direct Jobs Created

	2010-2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Berkshire	0	511	797	1,156	1,188	1,188	1,188	1,188	1,188	8,403
Cape and Islands	0	546	1,540	2,783	1,519	1,519	1,519	1,519	1,519	12,462
Central	0	(3,020)	(2,377)	(1,574)	(1,248)	(1,248)	(1,248)	(1,248)	(1,248)	(13,209)
Greater Boston	0	9,172	13,313	18,490	22,517	22,517	22,517	22,517	22,517	153,558
Northeast	0	1,789	3,280	5,145	4,084	4,084	4,084	4,084	4,084	30,634
Pioneer Valley	0	(77)	656	1,573	2,863	2,863	2,863	2,863	2,863	16,466
Southeast	0	(1,327)	(127)	1,372	1,578	1,578	1,578	1,578	1,578	7,807
Massachusetts	0	7,592	17,082	28,945	32,500	32,500	32,500	32,500	32,500	216,120

In order to estimate the employment impacts of constructing housing units, we use the Regional Input-Output Modeling System (RIMS II). Data for the RIMS model are provided at the state level from the Department of Commerce and the Bureau of Economic Analysis (BEA).[8] The RIMS regional models and multipliers are based on the national Input-Output accounts (by industry and based on relationships between industries) adjusted using the BEA's regional economic accounts.

Additional jobs may also be created by the increased consumption and spending by the newly employed workers. These indirect effects include jobs created in industries such as manufacturing,

[8] https://www.bea.gov/regional/rims/rimsii/

retail trade, transportation, warehousing, real estate, rental, and leasing.[9] There may also be induced impacts based on changes in spending by labor within the region (Exhibit 9). In general, multiplier effects must be considered carefully. They must be qualified by distinguishing real from nominal effects; and opportunity costs must be netted out.

Real effects occur when otherwise unemployed workers become engaged in market activity, such as in the state's current economic environment. In economies experiencing lower unemployment, the impact of housing production may be nominal (existing fully employed labor is shifted from one job to another, raising wage rates). Given the current rate of unemployment in the state (see Exhibit 9) and nationwide, we assume that additional jobs will increase employment, and that there are therefore real impacts through at least 2020, when unemployment rates in some industries are projected to return to normal. The opportunity cost is netted out of newly employed workers' wages.

Exhibit 9. Indirect or Induced Jobs Created

	2010-2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Berkshire	0	498	778	1,128	1,159	1,159	1,159	1,159	1,159	8,200
Cape and Islands	0	532	1,503	2,716	1,482	1,482	1,482	1,482	1,482	12,161
Central	0	(2,947)	(2,320)	(1,536)	(1,217)	(1,217)	(1,217)	(1,217)	(1,217)	(12,890)
Greater Boston	0	8,950	12,991	18,043	21,972	21,972	21,972	21,972	21,972	149,842
Northeast	0	1,745	3,201	5,020	3,985	3,985	3,985	3,985	3,985	29,892
Pioneer Valley	0	(76)	640	1,535	2,793	2,793	2,793	2,793	2,793	16,067
Southeast	0	(1,295)	(124)	1,339	1,540	1,540	1,540	1,540	1,540	7,618
Massachusetts	0	7,408	16,669	28,245	31,714	31,714	31,714	31,714	31,714	210,890

Jobs are expressed in the RIMS data in full-time person years of employment; this is regardless of the time period over which spending on new construction takes place. RIMS II, like all Input-Output models, is a "static equilibrium" model, so impacts calculated with RIMS II have no specific time dimension. The RIMS models are best suited for studying static impacts; longer-term employment impacts of new housing production are discussed below.[10]

The net benefit of a job must reflect the workers' cost of taking the job, or their opportunity cost. In the case of previously unemployed workers, this includes the loss of unemployment compensation benefits (a transfer) as well as time for leisure or other non-market activities. These costs of job creation were taken into account in estimating the net benefits of new jobs.

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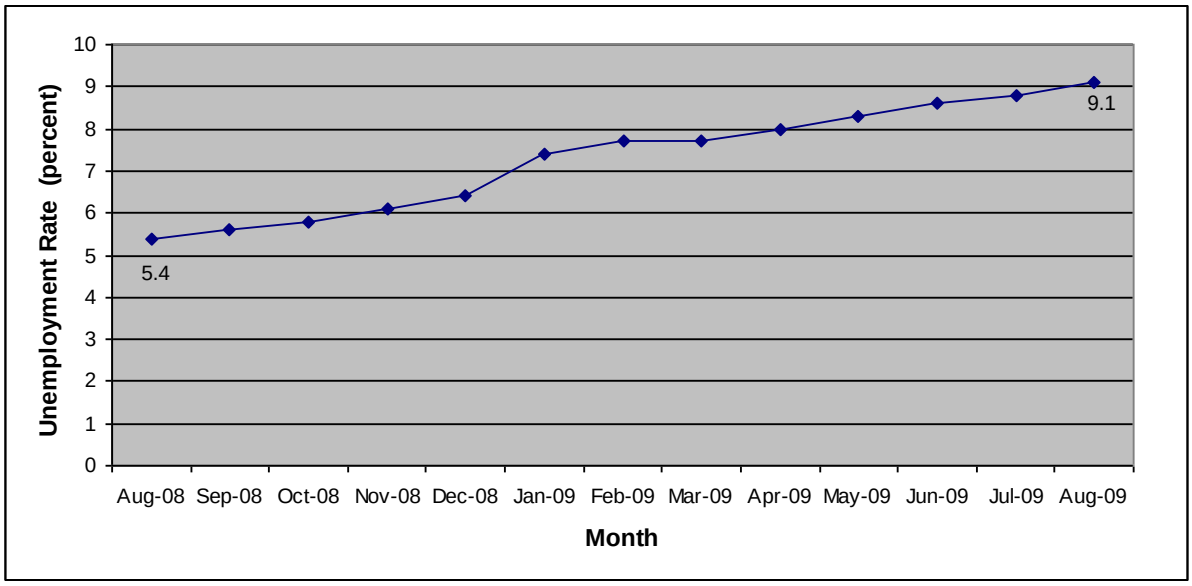
[9] There are 20 aggregated industries in RIMS, including construction, manufacturing, finance and insurance, real estate and rental and leasing, and educational services. Job creation is estimated separately for each industry. https://www.bea.gov/regional/rims/rimsii/download/Industry%20List%20C.pdf

[10] Shapiro, *et al.*, 2005.

Exhibit 10. Massachusetts Unemployment Rate: August 2008-August 2009
Seasonally Adjusted Data



Source: Massachusetts Department of Labor and Workforce Development, Labor Force and Unemployment Data. http://lmi2.detma.org/Lmi/lmi_lur_a.asp

Long-run job creation

In addition to housing production's direct and multiplier effects on employment, the state's housing supply has broader effects on economic growth. Recent research demonstrates that a constrained housing supply—one where supply is slow to respond to increases in demand—can lead to reductions in the rate of employment growth. Specifically, in inelastic housing markets, the labor market does not fully respond to an increase in labor demand, so that a 1 percent increase in labor demand leads to less than a 1 percent increase in employment.[11]

There is a great deal of evidence that the housing market in Massachusetts is inelastic: Massachusetts is consistently among the bottom performers nationwide in housing production per capita. Communities in the state also rank among the highest in the nation in levels of regulation in residential construction.[12]

The UMass Donahue team projects that loosening the constraints in the state's housing supply will allow the labor market to fully respond to increases in labor demand, resulting in an additional 208,637 jobs. As shown in Exhibit 11, roughly half of these are in the Greater Boston region.

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[11] Saks, 2005. The only portion of the state included in the study is the Boston metro area, but we assume the entire state's housing supply is constrained.

[12] Malpezzi, 1996.

Exhibit 11. Job Creation from Housing Production

Berkshire	Cape and Islands	Central	Greater Boston	Northeast	Pioneer Valley	Southeast	Total
3,281	5,957	22,516	104,556	27,230	18,652	26,445	208,638

The additional jobs created as a result of additional housing production could either put upward pressure on wages or increase employment (or both). We assume these jobs will take several years to materialize, by which time the unemployment rate is expected to be at normal levels. Therefore, we assume that long-run job creation creates no net benefits for workers, although the state benefits from additional tax revenues. Regardless of their net impact, we calculate the benefits to workers in the form of increased wages based on the number of jobs created in each industry and the estimated wages for each job.

Current Homeowners, Current Renters, and Landlords

Increasing the production of housing is likely to affect the housing market by reducing both rents and housing prices. Renters could benefit from both their lower rent payments and the lower house prices, which would increase opportunities for homeownership. A number of benefits have been attributed to homeownership, including equity accumulation, satisfaction with home and neighborhood, increased life satisfaction, improved health, and increased participation in voluntary and political activities. On the flip side, lower housing prices could result in losses for current owners who experience declines in the value of their homes. Similarly, declines in rent will affect landlords, who will receive less rental income.

Last, a long-term strategy for sustainable housing growth could increase the stability of home prices if it permanently increases the elasticity of supply, which would reduce the risk of holding housing as an asset. The evidence on the impact of a more elastic housing market is mixed, however, as discussed in the section, "Greater home price stability."

Lower rents

One of the consequences of slow housing production in Massachusetts is low vacancy rates among both rental and ownership units. The UMass Donahue Institute's housing production benchmarks for 2010 through 2020 include enough units to allow for a rental vacancy rate of 7.4 percent, a rate that research indicates is necessary for proper market function.[13] Rents and vacancy rates are negatively related, so constructing new rental units (and new ownership units, because of the interaction between the two markets) should reduce rents.[14]

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[13] Belsky, *et al.*, 2007.

[14] Benjamin, *et al.*, 1996.

We estimated the impact of new rental units using a simple linear relationship between vacancy rates, changes in operating expenses, and rents:[15,16]

$$R = b_0 + b_1E - b_2RV$$

Where R is the change in nominal rents over the time period, E is the rate of change in operating costs over the time period, and RV is the rental vacancy rate during the period. We assume that the natural vacancy rate is constant over the period, and is thus incorporated into b_0.

Inputs to this calculation include:

- Change in CPI rents based on CPI-All Urban Consumers, Rent of Primary Residence, Annual series for the Boston Metro Area (1986-2008)
- Housing vacancy rates from the Housing Vacancy Survey
- Change in operating expenses based on Institute of Real Estate Management Annual Income and Expense Analysis (1986-2008 estimates of expenses per square foot of rentable area)

Estimates from the regression are then applied to estimate the drop in rents under the stronger growth scenario using:

- Average rents from the 2006-2008 ACS
- Vacancy rates from the 2006-2008 ACS
- Rental units from UMass Donahue Institute projections
- Average change in operating expenses from 2004-2008

Benefits to renters are measured as consumer surplus, the benefit generated when a consumer is able to rent an apartment at a price lower than his or her willingness to pay for the apartment. Consumer surplus is represented by the area under the demand curve but above the new, lower, price (see Exhibit 12). However, we did not include the change in consumer surplus in the overall comparison of benefits and costs because we did not have sufficient information to be able to calculate the change in producer surplus. The loss in producer surplus would likely offset much of the increase in consumer surplus.

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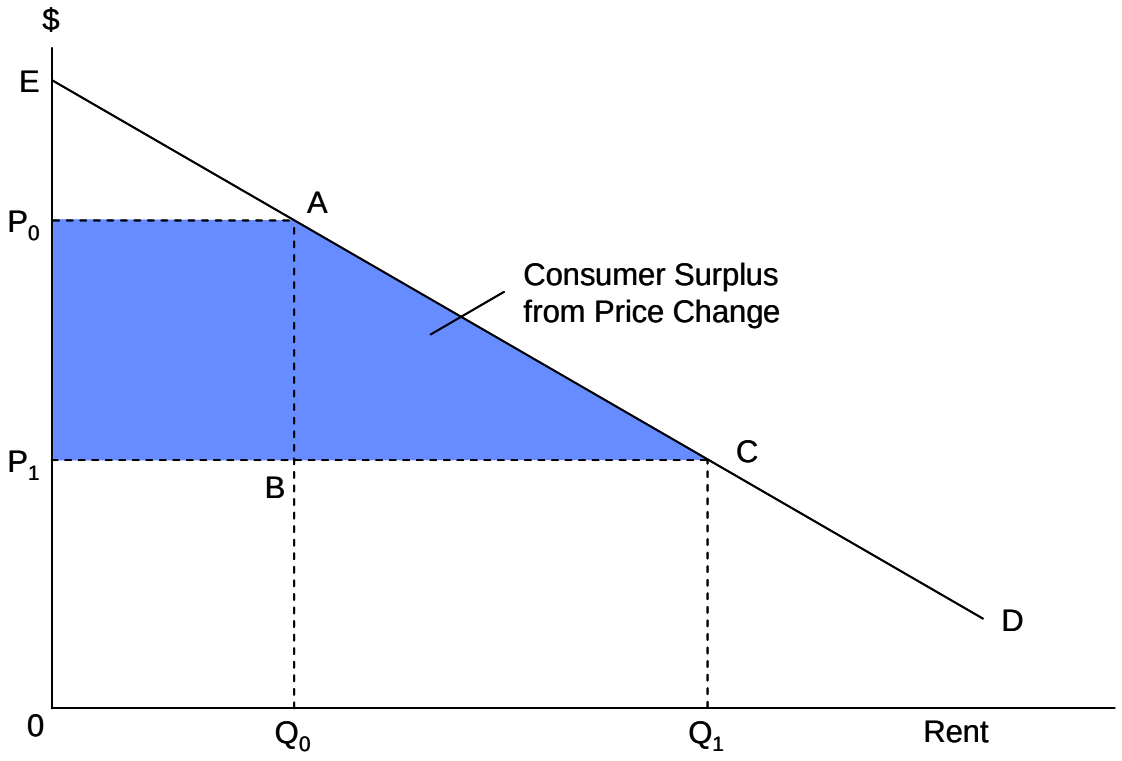
[15] Although some research suggests that the relationship is nonlinear, it is somewhat preliminary in nature. For example, Bluestone (2006) uses cross-sectional data and finds a good fit with a cubic function. More research is needed using cross-sectional time series data to further test this relationship.

[16] The model is from Rosen and Smith, 1983.

Exhibit 12. Consumer Surplus



For the purposes of illustration, the estimated impact on rents from the additional housing production is shown in Exhibits 13 and 14. These impacts are not included in the overall calculation of benefits and costs because they largely represent a transfer from landlords to renters. Although the impact on rents is small in most regions in the first several years, the impacts apply to all rental units (roughly 900,000 statewide in 2011), and therefore ultimately have a large overall impact.

Exhibit 13. Decline in Monthly Per-Unit Rents Under the Higher-Growth Scenario

	Berkshire	Cape and Islands	Central	Greater Boston	Northeast	Pioneer Valley	Southeast
2010-2012	$0	$0	$0	$0	$0	$0	$0
2013	$0	$4	$1	$4	$2	$3	$1
2014	$1	$11	$4	$12	$6	$9	$4
2015	$1	$23	$7	$25	$13	$19	$8
2016	$2	$38	$12	$42	$21	$32	$13
2017	$3	$57	$18	$64	$32	$49	$19
2018	$5	$80	$25	$91	$46	$70	$27
2019	$6	$107	$33	$123	$61	$96	$36
2020	$8	$140	$43	$161	$79	$126	$47

Exhibit 14. Total Difference in Annual Rents Under the Higher-Growth Scenario

	Berkshire	Cape and Islands	Central	Greater Boston	Northeast	Pioneer Valley	Southeast	Total
2010-2012	$0	$0	$0	$0	$0	$0	$0	$0
2013	$46,446	$925,469	$1,325,427	$20,035,299	$2,515,184	$3,263,697	$1,685,970	$29,797,492
2014	$144,211	$2,806,781	$3,970,929	$61,710,844	$7,682,774	$10,027,959	$5,152,177	$91,495,675
2015	$298,565	$5,733,176	$7,963,988	$127,050,590	$15,693,437	$20,593,342	$10,513,226	$187,846,324
2016	$515,781	$9,762,954	$13,382,539	$219,453,599	$26,735,791	$35,503,864	$17,920,737	$323,275,264
2017	$799,175	$15,031,126	$20,290,104	$340,991,662	$41,007,380	$55,101,524	$27,476,304	$500,697,275
2018	$1,151,773	$21,698,422	$28,784,677	$494,295,835	$58,725,094	$79,835,906	$39,295,304	$723,787,011
2019	$1,575,496	$29,969,124	$38,989,105	$682,118,659	$80,122,959	$110,196,715	$53,490,909	$996,462,967
2020	$2,071,055	$40,099,092	$51,053,421	$907,344,816	$104,679,316	$146,719,202	$70,173,754	$1,322,140,655

As shown, the additional housing units produced under the higher-growth scenario decrease overall rents paid by $29.8 million in 2013; by $91.5 million in 2014; and ultimately by over $1.3 billion in 2020. This is because additional units – and thus increasing rental vacancy rates – relieve pressure on the rental market, moderating rents.

Lower house prices

Construction of new single family units should reduce or slow the growth in home prices. The change in prices with new construction of units was estimated using the price elasticity of demand.

This calculation was based on published estimates of housing demand elasticity.[17] The change in house prices were measured against a baseline projection of house prices, from the New England Economic Partnership's forecast of the Massachusetts housing market.

Benefits to homebuyers in the form of lower house prices were measured as consumer surplus. Inputs to this calculation included:

- The difference between baseline and stronger growth scenario home prices
- The annual number of projected home sale transactions in the state
- Price elasticity of demand for ownership units in the state

The benefits to home buyers are offset by losses to current home owners who sell when housing prices have declined. However, sellers of newly constructed homes are assumed not to experience losses.

Benefits to homebuyers such as average annual equity accumulation, satisfaction with home and neighborhood, contribution to neighborhood stability, and increased participation in voluntary and political activities were not quantified, nor were some costs of homeownership, such as decreased individual mobility.[18]

Greater home price stability

The strategy may permanently increase the elasticity of the supply response to housing demand. The consequences of this change are unclear, however. Intuitively, a more flexible supply response should reduce the risk of homeownership by reducing the risk of both large run-ups in house prices (because the supply of housing will adjust to meet demand) and the large drops in prices that can result from these housing price bubbles. However, the societal impacts of increasing the responsiveness of supply are unclear.

There is evidence that elasticity of supply in a housing market is related to housing price volatility, with inelastic markets exhibiting higher volatility than markets with more elastic supply.[19] Further, there may be a positive relationship between house price volatility and financial returns to homeownership, with returns rising by 2.48 percent annually for a 10 percent rise in volatility.[20]

Although the financial impact of increased volatility can be positive for homeowners, the impact on society as a whole is less clear (and further, it is not clear that homeowners in volatile markets are

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17 See Glaeser, *et al.*, 2006; Ermisch, *et al.*, 1996; Zabel, 2004; Ioannides and Zabel, 2008; Ioannides and Zabel, 2003.

18 Evidence for these impacts of homeownership is reviewed in Rohe, *et al.*, 2001.

19 Malpezzi and Wachter, 2005; see also Pollakowski, 1999.

20 Cannon, *et al.,* 2005.

being adequately compensated for the additional risk). Places with more elastic housing supply may be less likely to experience housing price bubbles, have bubbles that involve smaller run-ups in house prices, and the duration of housing price bubbles when they do occur is likely to be shorter.[21]

However, it is not clear whether places with a flexible housing supply response may be more likely to overbuild when a bubble does occur. If they are, then in addition to the misuse of resources (building materials and labor), overbuilding can result in labor market inefficiencies. For example, the drop in home prices when the bubble ends can reduce mobility in the labor supply because homeowners are reluctant to sell their homes at a loss.

Because of this ambiguity, we will exclude the impacts of the housing production strategy on home price stability from our evaluation of costs and benefits.

Taxpayers

The primary potential impacts on taxpayers from additional new housing production result from increases in local school expenditures. Property, state income, sales and excise, and business tax revenue that derive from the net new jobs and housing have been projected by Alan Clayton-Matthews as part of the UMass Donahue Institute team's study, and were incorporated into our analysis.

In the stronger growth scenario, additional housing production is projected to result in additional job and population growth. The additional population of 392,833 estimated by the UMass Donahue Institute team will directly affect school expenditures. Importantly, some regions will see declines in school enrollment, and others will see increases.

Marginal cost approach of estimating local schooling costs

Although average costs are more commonly used than marginal costs to estimate local costs of education, they may overstate the costs of educating an additional child given the overhead costs of education that are not particularly sensitive to the number of children in the school district, such as administrative expenses (superintendent, curriculum development, etc.). This is particularly true in school districts where the number of additional students is relatively small. As the number of additional school children rises, however, marginal costs approach average costs. We use average cost in each region for our calculation of school costs, except in the first year of school enrollment increases, when increases in students in each district are quite small. In this year, we use the marginal cost.

Based on population projections from the UMass Donahue Institute team and Census projections of the age distribution of the population in 2020, we estimate a total of 52,168 new schoolchildren in the state as a result of the new housing production by 2020. As shown in Exhibit 15, they are

[21] Glaeser, *et al.,* 2008.

concentrated in the Greater Boston benchmark region, but there are significant additions in all regions except Berkshire and Cape and Islands.

Exhibit 15. Additional Schoolchildren by 2020

Berkshire	Cape and Islands	Central	Greater Boston	Northeast	Pioneer Valley	Southeast	Total
837	1,343	7,207	21,310	8,143	5,901	7,427	52,168

We estimate marginal costs using a simple regression to predict the relationship between the log of total expenditures per school district and number of students per school district: (controlling for median household income for the district, student/teacher ratio, average teacher salaries in the district, and the share of households in the district that are renters. A logarithmic function is used because the distribution of total expenditures is skewed, so a log transformation of the total expenditures conforms more to a normal distribution.

Data used are from the Massachusetts Department of Education and the American Community Survey (2006-2008). District-level data on household income and renter share of households were used where available; otherwise, we mapped districts to PUMAs and used PUMA-level data. For districts that could not be mapped to PUMAs (such as technical school districts), we used state-level data.

We assume that about 7 percent of students will opt for private or home school education, and will not impose any costs on the school district.[22] We subtract state education aid (Chapter 70) from the marginal or average cost per student to obtain the cost to the school district of each additional student. Costs at the school district level are then aggregated to the benchmark region level.

Communities

Additional new housing construction may have positive and negative consequences for the community: it could lead to loss of open space, the energy use of new households has environmental impacts, and new housing requires additional infrastructure. To the extent additional housing units lead to job growth and increases in the population, there will also be increases in school costs and increases in congestion and auto emissions from new commuters. On the positive side, communities will collect property tax revenues (calculated by the UMass Donahue Institute team) from the new units constructed. The extent of the costs and benefits to communities will depend in part on the specific location and type of new housing.

[22] Nakosteen, *et al.*, 2003.

Loss of open space

New residential housing production could consume some of the state's open space. Projections from the UMass Donahue Institute indicate that the supply of housing will leave demand unmet for almost 30,000 units by 2020. There is actually an overall projected surplus of over 6,000 single-family units but a shortage of nearly 34,000 multifamily units (see Exhibit 16). Although infill development could accommodate some of the additional units the construction of almost 170,000 additional housing units to balance supply and demand in the housing market will certainly require some open space for development.

Exhibit 16. Shortfall of Housing Units by 2020, by Benchmark Region and Housing Unit Type

	Berkshire	Cape and Islands	Central	Greater Boston	Northeast	Pioneer Valley	Southeast	Total
Single	(1,277)	(17)	18,220	(25,545)	(3,889)	6,757	12,202	6,452
Multi	(2,007)	(1,198)	(309)	(20,651)	4,767	(10,396)	(3,981)	(33,775)
Other	253	141	(636)	72	(311)	(1,205)	(918)	(2,603)
Total	(3,031)	(1,074)	17,275	(46,124)	568	(4,843)	7,303	(29,926)

This loss of open space has costs: open space has value as a natural system, the benefits of which include ground water recharge, flood control and storm damage prevention, open space related activities (camping, fishing, hiking), revenues generated by these activities, production value of open space, and other intangibles.[23]

However, if the strategy encourages sustainable housing production, more efficient development patterns could result. Smart growth development—compact development that is close to jobs, urban centers, and transit—could mitigate the loss of open space. For example, 18,500 new single-family homes built using lot sizes roughly equal to recent averages (1.3 acres in the Route 128/495 corridor from 1998 through 2002) would consume about 24,050 acres of land at 1.3 acres per unit. Average lot sizes were 1.1 acres when multifamily housing is included. In comparison, smart growth projects around the country are being constructed on a median lot size of .25 acres for each additional housing unit.[24] If new development were built on lots averaging .25 acres, the same number of units would consume 4,625 acres.

Energy use of new households

We considered the energy use of new households that relocate from outside the state to inside the state, but excluded this from the cost-benefit analysis because these households use energy regardless of their location, and carbon emissions do not respect state boundaries.

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[23] Fausold and Lilieholm, 1999.

[24] Moscovitch, 2005.

We also considered whether new households might form as a result of additional new housing production. Perhaps lower house prices would encourage less "doubling up," and result in fewer people per household. However, the UMass Donahue Institute team projects that household sizes will actually increase slightly in the stronger-growth scenario (from 2.6 to 2.62 people per household), which we take to be evidence that no household formation will be attributable to the housing production under the stronger-growth scenario.

Because all households simply relocate from elsewhere (or stay in Massachusetts instead of leaving), we assume the housing production does not cause any new energy use related to the operation of new housing units.

Increased congestion/commuting costs

The stronger growth scenario assumes that new housing development results in long-term job and population growth, which will increase the number of workers in the state and may lead to an increase in commuting time and a corresponding loss of productivity or leisure time. In addition, the short-term jobs that are directly and indirectly created in producing the additional units of new housing will increase the employment level in the state and may have impacts on congestion or commuting. The number of new commuters considered in this analysis is from both the short-and long-term job and population growth directly attributable to the production of almost 170,000 housing units. (The number of new long-term jobs attributable to the housing production has been projected by the UMass Donahue Institute team to be 208,638.)

Based on projections from the UMass Donahue Institute team and share of commuters in each region that either drive to work alone or carpool,[25] Exhibit 17 shows the number of new commuters that result from long-run employment growth due to housing production.

Exhibit 17. New Commuters from Additional Housing Production

Berkshire	Cape and Islands	Central	Greater Boston	Northeast	Pioneer Valley	Southeast	Statewide
2,758	5,013	19,623	71,203	23,349	15,696	22,849	175,359

To quantify the commuting impacts of additional households we used the following data:

- Estimate of the number of additional commuters in each region that is attributable to filling the gap between supply and demand for housing, and the mode of journey to work.
- Commute distance and time by benchmark region.

[25] The mode of journey to work by region is from Goodman, *et al.*, 2004. We assume that carpoolers travel with one other commuter, so each carpooler represents .5 additional cars on the road.

- Marginal external congestion costs for automobiles: these are estimated by the Federal Highway Administration to be between 1.2 cents and 13.2 cents per mile. This cost includes the recurring costs of the daily commute as well as non-recurring delays due to crashes and disabled vehicles.[26]
- The average wage of workers in Massachusetts by region.[27]

In estimating the costs of new commuters we assume:

- New commuters are slightly more likely to choose public transit to travel to work because new housing units are assumed to have better access to public transportation than other housing units.
- New commuters have commutes that are 10 percent shorter than the average for the benchmark region, because new housing units are assumed to have better access to employment centers.

One of the key impacts of the shortfall in housing production—particularly in locations that are accessible to employment opportunities—over the past decades appears to have been lengthening commutes. According to Goodman and his co-authors, Massachusetts commuters experienced the sixth largest increase in commute times in the nation from 1980-2000. Over the same period, Massachusetts' population grew much more slowly than the population of the U.S. as a whole—by about 10.7 percent compared with 24.2 percent.[28]

The report notes that in 1980, the average commute time in Massachusetts was roughly in line with the national average, but by 2000, Massachusetts commuters had the ninth longest commutes in the nation.[29] Interestingly, in 1980, Massachusetts house prices were also roughly in line with the national average,[30] indicating a correlation between increasing house prices and lengthening commute times. In other words, it appears that households have traded off short commute times in order to find affordable housing in desirable communities. With higher housing production focused in employment centers, workers could experience shorter commutes.

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[26] See Table V-23 2000 Marginal External Costs for Congestion (cents per mile). Available at http://www.fhwa.dot.gov/policy/hcas/final/five.htm

[27] The U.S. Department of Transportation recommends that analysts value local personal travel time at 50 percent of average wage. See "Departmental Guidance for the Valuation of Travel Time in Economic Analysis." Available at http://www.fhwa.dot.gov/infrastructure/asstmgmt/primer05.cfm

[28] Data for calculation are from the 2000 decennial census, and were downloaded from www.censusscope.org on March 15, 2010.

[29] Goodman, *et al.*, 2004.

[30] Based on Historical Census of Housing Tables, data downloaded on March 15, 2010 from http://www.census.gov/hhes/www/housing/census/historic/values.html.

The costs of lengthy commutes include increased air pollution and the economic and personal costs of lost time. Transportation-related contributions to overall CO2 emissions in Massachusetts have been increasing, and the entire state of Massachusetts is considered a "non-attainment area" for ozone pollution standards according to the EPA. The economic costs of commuting include lost work time as well as the personal costs of less family and community engagement.[31]

Costs of new infrastructure

With new construction, additional investments in infrastructure are likely to be needed. Infrastructure costs include costs of building/repairing roads, bridges, water and wastewater collection and treatment systems, and public buildings and capital equipment. Although Massachusetts municipalities have limited ability to impose impact fees, they often negotiate exactions from developers to defray infrastructure and other costs when they issue discretionary permits. To the extent that the infrastructure is funded by the developer, the costs will be incorporated into the cost of new housing and passed on to the occupants of the housing.[32] We assume that infrastructure not funded by developers will be borne by the state, and will not impose additional costs on cities and towns.

Capital expenses for new structures and equipment related to the new housing production are estimated based on a model developed by the National Association of Home Builders, which relies on data from the Census of Governments. The model assumes that there is no excess capacity in existing infrastructure.

Current expenses associated with new housing units are estimated using average per-capita municipal expenditures in Massachusetts communities (net of fees for services and excluding spending on schools, which are estimated separately). We convert per-capita municipal expenditures to average per-household costs, and assume that new housing units incur the same level of expenditures annually.

Key Assumptions

Key assumptions used in the evaluation of benefits and costs of additional housing production include the discount rate used to convert future monetary values into present value terms, the timing of various benefits and costs, and the durability of benefits and costs.

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[31] Goodman, *et al*., 2004, p. 32-33.

[32] The incidence of the exaction—who actually pays for the infrastructure—depends on the price elasticities of supply and demand for housing. The long-run price elasticity of supply is high relative to the price elasticity of demand for housing, so the exaction will be paid mostly by the consumer.

Present Value Analysis

Because the benefits and costs of additional housing production are expected to occur at different times over a ten-year period, the assumptions used to translate benefits and costs into present values are critical. The first assumption is the timing of specific events, in particular the additional housing production. A steady rate of construction over ten years will have a much different present value than construction that occurs primarily at the end of the ten-year period. Other assumptions relate to timing as well, such as the length of time required after housing production for house prices to adjust and the length of time required for increased flexibility in the housing market to produce a labor market impact.

Timing of Housing Unit Production

We assume that any strategy that encourages housing production in the Commonwealth takes three years to begin affecting construction, gradually increases over the following three years as people begin to respond to changes in incentives, and the final four years reflect full strategy impact. Housing production in the years 2010-2012, therefore, are the same for both the baseline and the stronger growth scenario—they follow the New England Economic Partnership's housing production forecasts. In 2013-2015, housing production increases 25 percent each year over the previous year, and there is level housing production over the years 2016-2020.

Durability of Benefits and Costs

Some benefits may be temporary, others more lasting; some benefits may not accrue for several years after housing construction while others accrue immediately. For example, we assume the jobs created as a result of the housing production are not permanent unless the strategy used to encourage production has a permanent impact on the market's ability to supply housing. However, there is a "real" impact of job creation—as opposed to nominal—only when the state's unemployment rate is projected to be above normal.

The appropriate discount rate for use in calculating the net present value of benefits and costs that occur at different times is a third critical assumption. We use the rate on a government-issued bond of similar duration to the project, in this case the rate on a ten-year Treasury Bill. The average rate on this bond from July 2009-July 2010 was 3.5 percent. The T-Bill represents an alternative investment that could be made if funds were not being directed to additional housing production. However, the discount rate should reflect both the time horizon and the risk of the project being evaluated. Therefore, some researchers argue that a much higher discount rate should be used when accounting for social benefits and costs, to reflect their typically uncertain nature.

Appendix

Sensitivity Analysis

To identify the impacts of key assumptions in the analysis of benefits and costs of housing production in Massachusetts, we conducted sensitivity analysis. This involved identifying each of the major assumptions used in the model, and changing the value of each assumption one at a time. Assumptions were increased and then decreased by 10 percent in order to identify assumptions that have asymmetric impacts on the results (such as the timing of full employment for industries other than the construction industry).

The results of the sensitivity analysis are shown in Exhibit A-1. The base assumption, or the assumption being used to estimate the benefits and costs of housing production, is shown in the first column. The value of the assumption as increased by 10 percent is shown next, along with the percentage change in net benefits and costs. The last two columns show the value of the assumption when it is decreased by 10 percent and the resulting impact on net benefits and costs in percentage terms.

Only one assumption has a disproportionate impact on the model (more than 10 percent impact on the results). This is the timing of full employment, because the jobs created are by far the largest source of benefits from housing production. This assumption captures the condition of the economy nationwide: we assume that the economy returns to full employment by 2020; but if the economy recovers more quickly, the benefits of housing production are nearly 25 percent smaller. This is because workers' opportunity costs are higher. That is, more alternative job options are available.

The impact of the employment-related assumptions (which are shaded in the table) highlights the importance of housing production as a tool for economic recovery. If the economy is healthy (and there is full employment), housing production inflates wages of existing workers rather than creating new jobs, and vice versa.

Exhibit A-1. Results of Sensitivity Analysis

Key Assumptions	Base Assumption	Increase in Base Assumption		Decrease in Base Assumption	
		Assumption	Impact on Results	Assumption	Impact on Results
Discount rate	3.5%	3.85%	-3.0%	3.15%	3.1%
Employment					
Number of long-term jobs created	208,637	229,501	6.3%	187,773	-6.3%
Timing of full employment	2020			2019	-24.6%
Opportunity costs of taking a job	50% of wage	55% of wage	-3.3%	45% of wage	3.3%
Short-term job creation	Varies by year		3.5%		-3.5%
Municipal expenditures					
Expenditures per new resident	$1,016	$1,118	-0.5%	$915	0.5%
Average cost of schooling	$5,250	$5,775	-0.3%	$4,725	0.3%
Costs of local infrastructure	$486	$534	-0.2%	$437	0.2%
Housing impacts					
Difference between **sales transactions** in baseline and stronger-growth scenarios	Varies by year		-0.6%		0.6%
Housing demand elasticity	-0.8	-0.5	0.6%		
Other impacts					
Costs of congestion	Varies by year		0.0%		0.0%

The relatively small impact of varying assumptions related to municipal expenditures per new resident, the average cost of schooling, and costs of local infrastructure related to new residents is comforting. It suggests that even if our assumptions are wrong by as much as 10 percent, the impact on the model is relatively small. Variance in the discount rate also has a small impact, which is reassuring given the uncertainty of inflation and the time value of money over the next decade.

Impacts of housing production on the housing market itself—perhaps surprisingly—are also generally modest. Changing the difference between the number of sales transactions in the baseline and stronger-growth scenarios has almost no impact.

The housing demand elasticity used to project the impact of new housing production on house prices is treated differently from the other assumptions. Rather than increasing and decreasing the base assumption by 10 percent, we substitute the one published estimate with another (Ermisch, Findlay, and Gibb's 1996 literature review identifies the range of elasticities to be about -0.8 percent to -0.5 percent). This assumption also has a small impact on results, but the sensitivity analysis also shows that it is conservative. Using a different estimate of housing demand elasticity results in an

increase in net benefits and costs, which gives us some confidence that the assumption is not overstating the case for housing production.

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