Attachment 4

The Local Impact of Home Building in a Typical Metro Area

Income, Jobs, and Taxes Generated

Prepared by the
Housing Policy Department

June 2009

National Association of Home Builders
1201 15th Street, NW
Washington, DC 20005
202-266-8398

The Local Impact of Home Building in a Typical Metro Area

Income, Jobs, and Taxes Generated

Contents

Executive Summary

Home building generates substantial local economic activity, including new income and jobs for residents, and additional revenue for local governments. The National Association of Home Builders has developed a model to estimate the economic benefits. The model captures the effect of the construction activity itself, the ripple impact that occurs when income earned from construction activity is spent and recycles in the local economy, and the ongoing impact that results from new homes becoming occupied by residents who pay taxes and buy locally produced goods and services. In order to fully appreciate the positive impact residential construction has on a community, it's important to include the ripple effects and the ongoing benefits. Since the NAHB model was initially developed in 1996, it has been successfully applied to construction in over 500 projects, local jurisdictions, metropolitan areas, non-metropolitan counties, and states across the country.

This report presents estimates of the local impacts of building 100 single family units, 100 rental apartments, and $10 million worth of spending on residential remodeling (equivalent to 100 remodeling jobs at $100,000 each)[1] in a typical U.S. metropolitan area, with the key inputs (such as new home prices, raw land values, and construction related fees) set equal to national averages.

The NAHB model produces impacts on income and employment in 16 industries and local government, as well as detailed information about taxes and other types of local government revenue. The key results are summarized below. Additional details are contained in subsequent sections.

Single-Family Construction

- The estimated one-year local impacts of building 100 single-family homes in a typical metro area include
    - $21.1 million in local income,
    - $2.2 million in taxes and other revenue for local governments, and
    - 324 local jobs.

  These are local impacts, representing income and jobs for local residents, and taxes (and other sources of revenue, including permit fees) for all local jurisdictions within the metro area. They are also one-year impacts that include both the direct and indirect impact of the construction activity itself, and the impact of local residents who earn money from the construction activity spending part of it within the local area.

[1] These are 100 times the inputs used in the 2008 article "The Direct Impact of Home Building and Remodeling on the U.S. Economy," which analyzed the impacts of building one average single family housing unit, one average rental apartment, and $100,000 worth of spending on residential remodeling on the national economy: (http://www.nahb.org/generic.aspx?sectionID=734&genericContentID=103543&channelID=311).

- The additional, annually recurring impacts of building 100 single-family homes in a typical metro area include
    - $3.1 million in local income,
    - $743,000 in taxes and other revenue for local governments, and
    - 53 local jobs.

  These are ongoing, annual local impacts that result from the new homes being occupied, and the occupants paying taxes and otherwise participating in the local economy year after year. The ongoing impacts also include the effect of increased property taxes, based on the difference between the value of raw land and the value of a completed housing unit on a finished lot, assuming that raw land would be taxed at the same rate as the completed housing unit.

The above impacts were calculated assuming that new single-family homes built in a typical metro area with an average price of $321,000; are built on a lot for which the average value of the raw land is $40,000; require the builder and developer to pay an average of $7,915 in impact, permit, and other fees to local governments; and incur an average property tax equal to one percent of the value of the home. To the extent that they are comparable, these housing unit characteristics are similar to the ones employed by NAHB recently to analyze the impact of single family construction at the national level.[2]

Multifamily Construction

- The estimated one-year local impacts of building 100 rental apartments in a typical metro area include
    - $7.9 million in local income,
    - $827,000 in taxes and other revenue for local governments, and
    - 122 local jobs.

  These are local impacts, representing income and jobs for residents of the metro area, and taxes (and other sources of revenue, including permit fees) for all local jurisdictions within the metro area. They are also one-year impacts that include both the direct and indirect impact of the construction activity itself, and the impact of local residents who earn money from the construction activity spending part of it within the local area.

- The additional, annually recurring impacts of building 100 rental apartments in a typical metro area include
    - $2.3 million in local income,
    - $395,000 in taxes and other revenue for local governments, and
    - 32 local jobs.

  These are ongoing, annual local impacts that result from the new apartments being occupied, and the occupants paying taxes and otherwise participating in the local economy year after year. They also represent impacts that have been reduced to account for the natural vacancy rate that tends to prevail in multifamily properties (see page 22 of the Technical Documentation).

[2] "The Direct Impact of Home Building and Remodeling on the U.S. Economy"

The above impacts were calculated assuming that the new rental apartments built in the typical metropolitan area have an average market value of $120,000 each, embody an average raw land value of $12,000, and require the builder and developer to pay an average of $3,043 in impact, permit, and other fees per unit to local governments; and incur an average property tax equal to one percent of the apartment's market value. As was the case for the assumptions underlying the single family impact estimates, these housing unit characteristics are similar to the ones employed by NAHB recently to analyze the impact of home building at the national level.

Residential Remodeling

- The estimated one-year local impacts of $10 million spent on remodeling in a typical metro area include
    - $6.9 million in local income,
    - $577,000 in taxes and other revenue for local governments, and
    - 78 local jobs.

  These are local impacts, representing income and jobs for residents of the typical metro area, and taxes (and other sources of revenue, including permit fees) for all local jurisdictions within the area. They are also one-year impacts that include both the direct and indirect impact of the construction activity itself, and the impact of local residents who earn money from the construction activity spending part of it within the metro area.

- Although certain remodeling jobs may be extensive enough to render otherwise uninhabitable units fit for occupancy (thereby allowing the metro area to retain extra households and triggering a set of ongoing impacts analogous to the impacts for new construction), the NAHB local impact model for remodeling does not assume this will be the case. The ongoing, annual economic benefits to the local economy are therefore limited to
    - $100,000 in residential property taxes.

  This assumes that remodeling increases the value of the property by the amount of the remodeling expenditure, and that the change in value is taxed at the same effective property tax rate as the completed housing units.

In addition to the treatment of property taxes, the estimated remodeling impacts assume that 1.25 percent of the value of the remodeling job is paid to a local jurisdiction in the metro area in the form of permit fees. Increases in the assessed value of the housing unit for tax purposes and permit fee payments are typical of remodeling work performed by professional contractors, such as members of NAHB Remodelers: http://www.nahb.org/page.aspx/category/sectionID=433.

The NAHB model can be used to estimate the local economic benefits of any combination of new single-family construction, new multifamily construction, and residential remodeling in a particular area. Although the estimated benefits will be spread over a market area, the construction analyzed can be constrained to a specific jurisdiction, or even an individual project. For more information about applying the NAHB model and obtaining a customized report for a particular area, contact either Paul Emrath (202-266-8449, pemrath@nahb.com) or Elliot Eisenberg (202- 266-8398, eeisenberg@nahb.com) in NAHB's Housing Policy Department.

The Local Impact of Home Building in a Typical Metro Area

Income, Jobs, and Taxes Generated

Detailed Tables on Single-Family Construction

Impact of Building 100 Single-Family Homes in a Typical Metro Area

Summary

Total One-Year Impact: Sum of Phase I and Phase II:

Local Income	Local Business Owners' Income	Local Wages and Salaries	Local Taxes[1]	Local Jobs Supported
$21,110,600	$6,272,000	$14,838,600	$2,202,700	324

Phase I: Direct and Indirect Impact of Construction Activity:

Local Income	Business Owners' Income	Local Wages and Salaries	Local Taxes[3]	Local Jobs Supported
$14,233,300	$3,996,700	$10,236,600	$1,333,000	213

Phase II: Induced (Ripple) Effect of Spending the Income and Taxes from Phase I:

Local Income	Business Owners' Income	Local Wages and Salaries	Local Taxes[1]	Local Jobs Supported
$6,877,300	$2,275,300	$4,602,000	$869,700	111

Phase III: Ongoing, Annual Effect that Occurs When New Homes are Occupied:

Local Income	Local Business Owners' Income	Local Wages and Salaries	Local Taxes[1]	Local Jobs Supported
$3,060,900	$897,900	$2,162,900	$743,300	53

[3] The term local taxes is used as a shorthand for local government revenue from all sources: taxes, fees, fines, revenue from government-owned enterprises, etc.

Impact of Building 100 Single-Family Homes in a Typical Metro Area
Phase I—Direct and Indirect Impact of Construction Activity

A. Local Income and Jobs by Industry

Industry	Local Income	Local Business Owners' Income	Local Wages and Salaries	Wages & Salaries per Full-time Job	Number of Local Jobs Supported
Construction	$9,758,100	$2,516,700	$7,241,400	$49,000	147
Manufacturing	$1,400	$100	$1,400	$51,000	0
Transportation	$22,300	$3,000	$19,300	$42,000	0
Communications	$146,100	$44,600	$101,400	$75,000	1
Utilities	$42,000	$16,300	$25,700	$84,000	0
Wholesale and Retail Trade	$1,432,200	$262,200	$1,170,000	$36,000	32
Finance and Insurance	$317,100	$25,800	$291,200	$83,000	4
Real Estate	$646,200	$568,900	$77,300	$51,000	2
Personal & Repair Services	$99,500	$37,500	$62,000	$33,000	2
Services to Dwellings / Buildings	$57,000	$11,300	$45,700	$33,000	1
Business & Professional Services	$1,375,500	$410,400	$965,100	$58,000	17
Eating and Drinking Places	$47,300	$6,400	$40,900	$20,000	2
Automobile Repair & Service	$47,100	$14,600	$32,500	$33,000	1
Entertainment Services	$8,200	$1,700	$6,500	$45,000	0
Health, Educ. & Social Services	$1,800	$500	$1,400	$38,000	0
Local Government	$19,000	$0	$19,000	$54,000	0
Other	$212,500	$76,700	$135,800	$44,000	3
Total	$14,233,300	$3,996,700	$10,236,600	$48,000	213

B. Local Government General Revenue by Type

TAXES:		USER FEES & CHARGES:	
Business Property Taxes	$54,800	Residential Permit / Impact Fees	$791,500
Residential Property Taxes	$0	Utilities & Other Govt. Enterprises	$144,900
General Sales Taxes	$102,900	Hospital Charges	$62,700
Specific Excise Taxes	$7,500	Transportation Charges	$26,300
Income Taxes	$28,000	Education Charges	$27,500
License Taxes	$1,600	Other Fees and Charges	$78,300
Other Taxes	$7,100	TOTAL FEES & CHARGES	$1,131,100
TOTAL TAXES	$201,900	TOTAL GENERAL REVENUE	$1,333,000

Impact of Building 100 Single-Family Homes in a Typical Metro Area
Phase II—Induced Effect of Spending Income and Tax Revenue from Phase I

A. Local Income and Jobs by Industry

Industry	Local Income	Local Business Owners' Income	Local Wages and Salaries	Wages & Salaries per Full-time Job	Number of Local Jobs Supported
Construction	$318,500	$123,400	$195,100	$49,000	4
Manufacturing	$1,400	$100	$1,300	$51,000	0
Transportation	$23,400	$3,200	$20,200	$38,000	1
Communications	$409,700	$140,000	$269,700	$74,000	4
Utilities	$197,400	$77,900	$119,400	$84,000	1
Wholesale and Retail Trade	$1,153,100	$217,100	$936,000	$32,000	29
Finance and Insurance	$289,800	$26,200	$263,600	$74,000	4
Real Estate	$1,214,000	$1,068,700	$145,300	$51,000	3
Personal & Repair Services	$246,800	$113,400	$133,400	$33,000	4
Services to Dwellings / Buildings	$59,300	$11,800	$47,500	$33,000	1
Business & Professional Services	$652,100	$193,600	$458,600	$52,000	9
Eating and Drinking Places	$337,900	$45,500	$292,500	$20,000	15
Automobile Repair & Service	$166,200	$50,600	$115,500	$33,000	4
Entertainment Services	$79,400	$21,900	$57,500	$37,000	2
Health, Educ. & Social Services	$928,200	$116,900	$811,300	$49,000	17
Local Government	$617,600	$0	$617,600	$50,000	12
Other	$182,500	$65,000	$117,500	$35,000	3
Total	$6,877,300	$2,275,300	$4,602,000	$41,000	111

B. Local Government General Revenue by Type

TAXES:		USER FEES & CHARGES:	
Business Property Taxes	$235,300	Residential Permit / Impact Fees	$0
Residential Property Taxes	$0	Utilities & Other Govt. Enterprises	$263,100
General Sales Taxes	$76,200	Hospital Charges	$97,800
Specific Excise Taxes	$32,000	Transportation Charges	$12,700
Income Taxes	$18,400	Education Charges	$13,300
License Taxes	$1,400	Other Fees and Charges	$89,900
Other Taxes	$29,700	TOTAL FEES & CHARGES	$476,700
TOTAL TAXES	$392,900	TOTAL GENERAL REVENUE	$869,700

Impact of Building 100 Single-Family Homes in a Typical Metro Area
Phase III—Ongoing, Annual Effect That Occurs Because Units Are Occupied

A. Local Income and Jobs by Industry

Industry	Local Income	Local Business Owners' Income	Local Wages and Salaries	Wages & Salaries per Full-time Job	Number of Local Jobs Supported
Construction	$167,300	$64,200	$103,100	$49,000	2
Manufacturing	$700	$100	$600	$51,000	0
Transportation	$9,800	$1,300	$8,500	$41,000	0
Communications	$186,900	$63,600	$123,300	$74,000	2
Utilities	$103,600	$40,800	$62,800	$84,000	1
Wholesale and Retail Trade	$566,800	$106,700	$460,100	$32,000	14
Finance and Insurance	$182,800	$16,600	$166,200	$73,000	2
Real Estate	$338,900	$298,400	$40,600	$51,000	1
Personal & Repair Services	$94,400	$43,500	$50,800	$33,000	2
Services to Dwellings / Buildings	$30,600	$6,100	$24,500	$33,000	1
Business & Professional Services	$299,800	$90,400	$209,300	$52,000	4
Eating and Drinking Places	$166,900	$22,500	$144,500	$20,000	7
Automobile Repair & Service	$78,300	$23,900	$54,400	$33,000	2
Entertainment Services	$49,000	$13,400	$35,500	$34,000	1
Health, Educ. & Social Services	$410,800	$53,400	$357,400	$48,000	7
Local Government	$235,900	$0	$235,900	$50,000	5
Other	$138,400	$53,000	$85,400	$35,000	2
Total	$3,060,900	$897,900	$2,162,900	$41,000	53

B. Local Government General Revenue by Type

TAXES:		USER FEES & CHARGES:	
Business Property Taxes	$103,600	Residential Permit / Impact Fees	$0
Residential Property Taxes	$281,000	Utilities & Other Govt. Enterprises	$159,300
General Sales Taxes	$33,600	Hospital Charges	$78,500
Specific Excise Taxes	$14,100	Transportation Charges	$5,600
Income Taxes	$8,200	Education Charges	$5,900
License Taxes	$600	Other Fees and Charges	$39,700
Other Taxes	$13,100	TOTAL FEES & CHARGES	$289,100
TOTAL TAXES	$454,200	TOTAL GENERAL REVENUE	$743,300

The Local Impact of Home Building in a Typical Metro Area

Income, Jobs, and Taxes Generated

Detailed Tables on Multifamily Construction

Impact of Building 100 Multifamily Units in a Typical Metro Area

Summary

Total One-Year Impact: Sum of Phase I and Phase II:

Local Income	Local Business Owners' Income	Local Wages and Salaries	Local Taxes[1]	Local Jobs Supported
$7,889,000	$2,300,800	$5,587,900	$826,800	122

Phase I: Direct and Indirect Impact of Construction Activity:

Local Income	Business Owners' Income	Local Wages and Salaries	Local Taxes[1]	Local Jobs Supported
$5,317,500	$1,450,500	$3,866,700	$501,800	80

Phase II: Induced (Ripple) Effect of Spending the Income and Taxes from Phase I:

Local Income	Business Owners' Income	Local Wages and Salaries	Local Taxes[1]	Local Jobs Supported
$2,571,500	$850,300	$1,721,200	$325,000	42

Phase III: Ongoing, Annual Effect that Occurs When New Homes are Occupied:

Local Income	Local Business Owners' Income	Local Wages and Salaries	Local Taxes[1]	Local Jobs Supported
$2,273,900	$972,400	$1,301,700	$395,000	32

[1] The term local taxes is used as a shorthand for local government revenue from all sources: taxes, fees, fines, revenue from government-owned enterprises, etc.

Impact of Building 100 Multifamily Units in a Typical Metro Area
Phase I—Direct and Indirect Impact of Construction Activity

A. Local Income and Jobs by Industry

Industry	Local Income	Local Business Owners' Income	Local Wages and Salaries	Wages & Salaries per Full-time Job	Number of Local Jobs Supported
Construction	$3,707,200	$956,000	$2,751,100	$49,000	56
Manufacturing	$500	$0	$500	$51,000	0
Transportation	$8,400	$1,100	$7,300	$42,000	0
Communications	$55,000	$16,800	$38,200	$75,000	1
Utilities	$15,500	$6,000	$9,500	$84,000	0
Wholesale and Retail Trade	$536,800	$98,200	$438,600	$37,000	12
Finance and Insurance	$118,500	$9,600	$108,800	$83,000	1
Real Estate	$172,900	$152,200	$20,700	$51,000	0
Personal & Repair Services	$37,600	$14,200	$23,400	$33,000	1
Services to Dwellings / Buildings	$21,000	$4,200	$16,800	$33,000	1
Business & Professional Services	$517,900	$154,500	$363,400	$58,000	6
Eating and Drinking Places	$17,700	$2,400	$15,300	$20,000	1
Automobile Repair & Service	$17,800	$5,500	$12,300	$33,000	0
Entertainment Services	$3,100	$600	$2,400	$45,000	0
Health, Educ. & Social Services	$700	$200	$500	$38,000	0
Local Government	$6,400	$0	$6,400	$54,000	0
Other	$80,500	$29,000	$51,500	$44,000	1
Total	$5,317,500	$1,450,500	$3,866,700	$48,000	80

B. Local Government General Revenue by Type

TAXES:		USER FEES & CHARGES:	
Business Property Taxes	$17,400	Residential Permit / Impact Fees	$304,300
Residential Property Taxes	$0	Utilities & Other Govt. Enterprises	$54,100
General Sales Taxes	$38,400	Hospital Charges	$23,400
Specific Excise Taxes	$2,400	Transportation Charges	$9,800
Income Taxes	$10,400	Education Charges	$10,300
License Taxes	$600	Other Fees and Charges	$28,500
Other Taxes	$2,300	TOTAL FEES & CHARGES	$430,400
TOTAL TAXES	$71,400	TOTAL GENERAL REVENUE	$501,800

Impact of Building 100 Multifamily Units in a Typical Metro Area
Phase II—Induced Effect of Spending Income and Tax Revenue from Phase I

A. Local Income and Jobs by Industry

Industry	Local Income	Local Business Owners' Income	Local Wages and Salaries	Wages & Salaries per Full-time Job	Number of Local Jobs Supported
Construction	$119,000	$46,100	$72,900	$49,000	1
Manufacturing	$500	$0	$500	$51,000	0
Transportation	$8,700	$1,200	$7,500	$38,000	0
Communications	$153,100	$52,300	$100,800	$74,000	1
Utilities	$73,800	$29,100	$44,600	$84,000	1
Wholesale and Retail Trade	$430,900	$81,100	$349,800	$32,000	11
Finance and Insurance	$108,300	$9,800	$98,500	$74,000	1
Real Estate	$453,700	$399,400	$54,300	$51,000	1
Personal & Repair Services	$92,200	$42,400	$49,900	$33,000	2
Services to Dwellings / Buildings	$22,200	$4,400	$17,800	$33,000	1
Business & Professional Services	$243,900	$72,400	$171,500	$52,000	3
Eating and Drinking Places	$126,300	$17,000	$109,300	$20,000	5
Automobile Repair & Service	$62,100	$18,900	$43,200	$33,000	1
Entertainment Services	$29,700	$8,200	$21,500	$37,000	1
Health, Educ. & Social Services	$346,900	$43,700	$303,200	$49,000	6
Local Government	$232,000	$0	$232,000	$50,000	5
Other	$68,200	$24,300	$43,900	$35,000	1
Total	$2,571,500	$850,300	$1,721,200	$41,000	42

B. Local Government General Revenue by Type

TAXES:		USER FEES & CHARGES:	
Business Property Taxes	$88,000	Residential Permit / Impact Fees	$0
Residential Property Taxes	$0	Utilities & Other Govt. Enterprises	$98,000
General Sales Taxes	$28,000	Hospital Charges	$37,000
Specific Excise Taxes	$12,000	Transportation Charges	$5,000
Income Taxes	$7,000	Education Charges	$5,000
License Taxes	$1,000	Other Fees and Charges	$34,000
Other Taxes	$11,000	TOTAL FEES & CHARGES	$178,000
TOTAL TAXES	$147,000	TOTAL GENERAL REVENUE	$325,000

Impact of Building 100 Multifamily Units in a Typical Metro Area
Phase III—Ongoing, Annual Effect That Occurs Because Units Are Occupied

A. Local Income and Jobs by Industry

Industry	Local Income	Local Business Owners' Income	Local Wages and Salaries	Wages & Salaries per Full-time Job	Number of Local Jobs Supported
Construction	$72,000	$23,200	$48,800	$49,000	1
Manufacturing	$400	$0	$400	$51,000	0
Transportation	$6,500	$900	$5,600	$39,000	0
Communications	$116,100	$39,700	$76,500	$74,000	1
Utilities	$30,300	$11,900	$18,400	$84,000	0
Wholesale and Retail Trade	$370,300	$69,800	$300,500	$32,000	9
Finance and Insurance	$77,400	$6,900	$70,500	$75,000	1
Real Estate	$736,500	$648,400	$88,200	$51,000	2
Personal & Repair Services	$52,400	$24,400	$28,000	$33,000	1
Services to Dwellings / Buildings	$17,300	$3,400	$13,800	$33,000	0
Business & Professional Services	$195,000	$59,200	$135,900	$52,000	3
Eating and Drinking Places	$122,600	$16,500	$106,100	$20,000	5
Automobile Repair & Service	$48,000	$14,600	$33,400	$33,000	1
Entertainment Services	$25,400	$7,100	$18,300	$42,000	0
Health, Educ. & Social Services	$230,900	$31,300	$199,600	$49,000	4
Local Government	$128,400	$0	$128,400	$50,000	3
Other	$44,400	$15,100	$29,300	$35,000	1
Total	$2,273,900	$972,400	$1,301,700	$40,000	32

B. Local Government General Revenue by Type

TAXES:		USER FEES & CHARGES:	
Business Property Taxes	$87,000	Residential Permit / Impact Fees	$0
Residential Property Taxes	$108,000	Utilities & Other Govt. Enterprises	$67,000
General Sales Taxes	$28,000	Hospital Charges	$34,000
Specific Excise Taxes	$12,000	Transportation Charges	$4,000
Income Taxes	$6,000	Education Charges	$4,000
License Taxes	$0	Other Fees and Charges	$32,000
Other Taxes	$11,000	TOTAL FEES & CHARGES	$142,000
TOTAL TAXES	$253,000	TOTAL GENERAL REVENUE	$395,000

The Local Impact of Home Building in a Typical Metro Area

Income, Jobs, and Taxes Generated

Detailed Tables on Residential Remodeling

Impact of $10 Million Spent on Residential Remodeling in a Typical Metro Area

Summary

Total One-Year Impact: Sum of Phase I and Phase II:

Local Income	Local Business Owners' Income	Local Wages and Salaries	Local Taxes[1]	Local Jobs Supported
$6,927,000	$3,432,000	$3,494,000	$577,000	78

Phase I: Direct and Indirect Impact of Construction Activity:

Local Income	Business Owners' Income	Local Wages and Salaries	Local Taxes[5]	Local Jobs Supported
$4,730,000	$2,689,000	$2,040,000	$294,000	43

Phase II: Induced (Ripple) Effect of Spending the Income and Taxes from Phase I:

Local Income	Business Owners' Income	Local Wages and Salaries	Local Taxes[1]	Local Jobs Supported
$2,197,000	$743,000	$1,454,000	$283,000	35

Phase III: Ongoing, Annual Effect:

Residential Property Taxes
$100,000

[5] The term local taxes is used as a shorthand for local government revenue from all sources: taxes, fees, fines, revenue from government-owned enterprises, etc.

Impact of $10 Million Spent on Residential Remodeling in a Typical Metro Area
Phase I—Direct and Indirect Impact of Construction Activity

A. Local Income and Jobs by Industry

Industry	Local Income	Local Business Owners' Income	Local Wages and Salaries	Wages & Salaries per Full-time Job	Number of Local Jobs Supported
Construction	$3,456,000	$2,333,000	$1,123,000	$49,000	23
Manufacturing	$0	$0	$0	$51,000	0
Transportation	$7,000	$1,000	$6,000	$43,000	0
Communications	$44,000	$12,000	$31,000	$76,000	0
Utilities	$9,000	$4,000	$6,000	$84,000	0
Wholesale and Retail Trade	$484,000	$88,000	$396,000	$37,000	11
Finance and Insurance	$73,000	$6,000	$68,000	$84,000	1
Real Estate	$78,000	$69,000	$9,000	$51,000	0
Personal & Repair Services	$40,000	$15,000	$25,000	$33,000	1
Services to Dwellings / Buildings	$12,000	$2,000	$10,000	$33,000	0
Business & Professional Services	$422,000	$122,000	$300,000	$60,000	5
Eating and Drinking Places	$12,000	$2,000	$10,000	$20,000	1
Automobile Repair & Service	$21,000	$6,000	$14,000	$33,000	0
Entertainment Services	$2,000	$0	$2,000	$46,000	0
Health, Educ. & Social Services	$1,000	$0	$0	$38,000	0
Local Government	$5,000	$0	$5,000	$54,000	0
Other	$64,000	$29,000	$35,000	$42,000	1
Total	$4,730,000	$2,689,000	$2,040,000	$47,000	43

B. Local Government General Revenue by Type

TAXES:		USER FEES & CHARGES:	
Business Property Taxes	$11,000	Residential Permit / Impact Fees	$125,000
Residential Property Taxes	$0	Utilities & Other Govt. Enterprises	$48,000
General Sales Taxes	$34,000	Hospital Charges	$21,000
Specific Excise Taxes	$2,000	Transportation Charges	$9,000
Income Taxes	$9,000	Education Charges	$9,000
License Taxes	$0	Other Fees and Charges	$24,000
Other Taxes	$1,000	TOTAL FEES & CHARGES	$236,000
TOTAL TAXES	$58,000	TOTAL GENERAL REVENUE	$294,000

Impact of $10 Million Spent on Residential Remodeling in a Typical Metro Area
Phase II—Induced Effect of Spending Income and Tax Revenue from Phase I

A. Local Income and Jobs by Industry

Industry	Local Income	Local Business Owners' Income	Local Wages and Salaries	Wages & Salaries per Full-time Job	Number of Local Jobs Supported
Construction	$104,000	$40,000	$63,000	$49,000	1
Manufacturing	$0	$0	$0	$51,000	0
Transportation	$8,000	$1,000	$7,000	$38,000	0
Communications	$133,000	$46,000	$88,000	$74,000	1
Utilities	$65,000	$26,000	$39,000	$84,000	0
Wholesale and Retail Trade	$378,000	$71,000	$307,000	$32,000	9
Finance and Insurance	$95,000	$9,000	$86,000	$74,000	1
Real Estate	$398,000	$350,000	$48,000	$51,000	1
Personal & Repair Services	$80,000	$37,000	$43,000	$33,000	1
Services to Dwellings / Buildings	$19,000	$4,000	$16,000	$33,000	0
Business & Professional Services	$205,000	$61,000	$143,000	$52,000	3
Eating and Drinking Places	$111,000	$15,000	$96,000	$20,000	5
Automobile Repair & Service	$54,000	$17,000	$38,000	$33,000	1
Entertainment Services	$26,000	$7,000	$19,000	$37,000	1
Health, Educ. & Social Services	$305,000	$38,000	$266,000	$49,000	5
Local Government	$156,000	$0	$156,000	$51,000	3
Other	$60,000	$21,000	$39,000	$35,000	1
Total	$2,197,000	$743,000	$1,454,000	$41,000	35

B. Local Government General Revenue by Type

TAXES:		USER FEES & CHARGES:	
Business Property Taxes	$77,000	Residential Permit / Impact Fees	$0
Residential Property Taxes	$0	Utilities & Other Govt. Enterprises	$86,000
General Sales Taxes	$25,000	Hospital Charges	$32,000
Specific Excise Taxes	$10,000	Transportation Charges	$4,000
Income Taxes	$6,000	Education Charges	$4,000
License Taxes	$0	Other Fees and Charges	$29,000
Other Taxes	$10,000	TOTAL FEES & CHARGES	$155,000
TOTAL TAXES	$128,000	TOTAL GENERAL REVENUE	$283,000

The Metro Area Impact of Home Building in a Typical Metro Area

Income, Jobs, and Taxes Generated

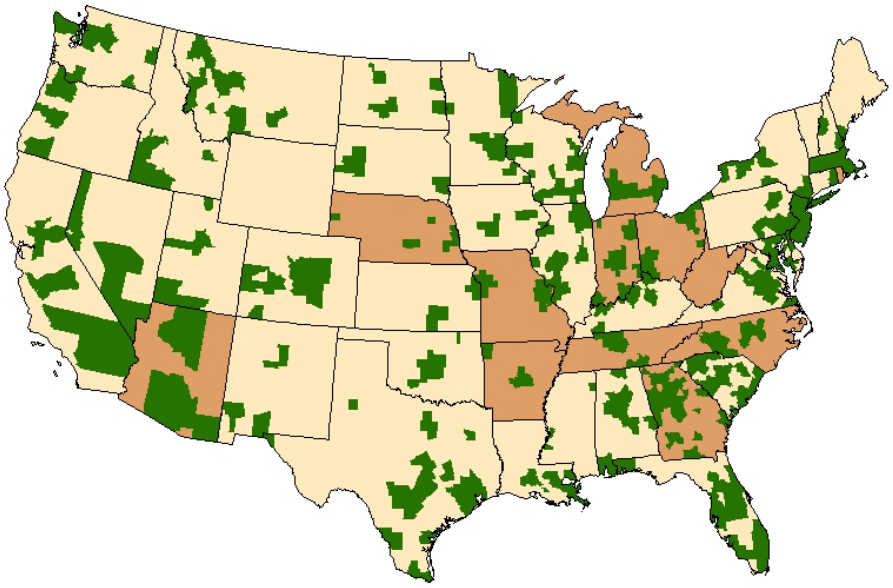
Background and a Brief Description of the Model Used to Estimate the Economic Benefits

The Housing Policy Department of the National Association of Home Builders (NAHB) maintains an economic model that it uses to estimate the local economic benefits of home building. Originally developed in 1996, the model was at first calibrated to a typical metropolitan area using national averages, but from the beginning was capable of being adapted to a specific local economy by replacing key housing market variables. The initial version of the model could be applied to single-family construction, multifamily construction, or a combination of the two.

In March of 1997, NAHB began customizing the model to various areas around the country on a routine basis, primarily at the request of its local affiliated associations. As of June 2009, the Housing Policy Department has produced over 600 of these customized reports analyzing residential construction in various metropolitan areas, non-metropolitan counties, and states across the country (see map below).

Areas Covered by NAHB Local Impact Studies

The darkest shading indicates studies that covered metro areas and non-metro counties; the somewhat lighter shading indicates studies that were produced for an entire state.



The reports have analyzed the impacts of specific housing projects, as well as total home building in areas as large as entire states. In 2002, NAHB developed new versions of the model to analyze active adult housing projects and multifamily development financed with the Low-Income Housing Tax Credit, then in 2005 a version of the model that analyzes remodeling.

Results from NAHB's local impact model have been used by outside organizations such as universities, state housing authorities and affordable housing agencies:

- The Shimburg Center for Affordable Housing at the University of Florida used results from the NAHB model to establish that "the real estate taxes paid year after year are the most obvious long-term economic benefit to the community. Probably the second most obvious long-term economic benefit is the purchases made by the family occupying the completed home." www.shimberg.ufl.edu/pdf/Newslett-June02.pdf

- The Louisville Affordable Housing Trust Fund (AHTF) used results from the NAHB model to determine the initial one-year impact and the ongoing annual effect that occurs when new homes are occupied. This analysis was performed to help justify the creation of a commission to oversee the newly established AHTF to insure that it works at "finding creative ways to create a sustainable and renewable fund to provide affordable housing opportunities throughout the Louisville community." www.openthedoorlouisville.org/housing-trust/economic-growth

- The Illinois Housing Development Authority used the NAHB model to determine that "the Authority's new construction activity in single and multifamily housing….resulted in the creation of 4,256 full-time jobs in construction and construction-related industries." The Authority also used the NAHB impact model to determine the federal, state and local taxes and fees generated from new construction and substantial rehabilitation activity. www.ihda.org/admin/Upload/Files/94c0ecf7-a238-4be3-90bd-6043cfae81ea.pdf

- The Stardust Center at the Arizona State University used "the model used and developed by the NAHB to assess the immediate economic impacts of affordable housing" by phase including the construction effect, the construction ripple, and on-going impacts. This was done to show "that permanent, affordable and geographically accessible housing provides numerous benefits both to individual families and to the broader community." www.orangecountyfl.net/NR/rdonlyres/efo5wiffiqvqqgn2s35shus5i4lwdgqbcxpck2dddnds3msj5qs26ubzllsfl6s6rrwnmtkq4dypnjrdrdzei2llq5g/Socialeconomicimpacts.pdf

- The Center for Applied Economic Research at Montana State University used "results from an input-output model developed by the National Association of Home Builders to assess the impacts to local areas from new home construction." The results show that "the construction industry contributes substantially to Montana's economy accounting for 5.5 percent of Gross State Product."

- The Housing Education and Research Center at Michigan State University also adopted the NAHB approach: "The underlying basis for supporting the implementation of this [NAHB] model on Michigan communities is that it provides quantifiable results that link new residential development with commercial and other forms of development therefore illustrating the overall economic effects of residential growth."

- The Center for Economic Development at the University of Massachusetts found that "Home building generates substantial local economic activity, including income, jobs, and revenue for state and local governments. These far exceed the school costs-to-property-tax ratios. …these factors were evaluated by means of a quantitative assessment of data from the National Association of Home Builder's Local Impact of Home Building model."

- Similarly, the Association of Oregon Community Development Organizations decided to base its analysis of affordable housing on the NAHB model, stating that "This model is widely respected and utilized in analyzing the economic impact of market rate housing development," and that, compared to alternatives, it "is considered the most

comprehensive and is considered an improvement on most previous models." www.aocdo.org/docs/EcoDevoStudyFinal.pdf

- The Boone County Kentucky Planning Commission included results from the NAHB model in its 2005 Comprehensive Report. The Planning Commission used values from the impact model to quantify the increase in local income, taxes, revenue, jobs, and overall local economic impacts in the Metro Area as a result of new home construction.

The NAHB model is divided into three phases. Phases I and II are one-time effects. Phase I captures the effects that result directly from the construction activity itself and the local industries that contribute to it. Phase II captures the effects that occur as a result of the wages and profits from Phase I being spent in the local economy. Phase III is an ongoing, annual effect that includes property tax payments and the result of the completed unit being occupied.

Phase I: Local Industries Involved in Home Building

The jobs, wages, and local taxes (including permit, utility connection, and impact fees) generated by the actual development, construction, and sale of the home. These jobs include on-site and off-site construction work as well as jobs generated in retail and wholesale sales of components, transportation to the site, and the professional services required to build a home and deliver it to its final customer.

Phase II: Ripple Effect

The wages and profits for local area residents earned during the construction period are spent on other locally produced goods and services. This generates additional income for local residents, which is spent on still more locally produced goods and services, and so on. This continuing recycling of income back into the community is usually called a ***multiplier*** or ***ripple*** effect.

Phase III: Ongoing, Annual Effect

The local jobs, income, and taxes generated as a result of the home being occupied. A household moving into a new home generally spends about three-fifths of its income on goods and services sold in the local economy. A fraction of this will become income for local workers and local businesses proprietors. In a typical local area, the household will also pay 1.25 percent of its income to local governments in the form of taxes and user fees, and a fraction of this will become income for local government employees. This is the first step in another set of economic ripples that cause a permanent increase in the level of economic activity, jobs, wages, and local tax receipts.

Modeling a Local Economy

The model defines a local economy as a collection of industries and commodities. These are selected from the detailed benchmark input-output tables produced by the U.S. Bureau of Economic Analysis. The idea is to choose goods and services that would typically be produced, sold, and consumed within a local market area. Laundry services would qualify, for example, while automobile manufacturing would not. Both business-to-business and business-to-consumer transactions are considered. In general the model takes a conservative approach and retains a relatively small number of the available industries and commodities. Of the roughly 600 industries and commodities provided in the input-output files, the model uses only 87 commodities and 89 industries.

The design of the model implies that a local economy should include not only the places people live, but also the places where they work, shop, typically go for entertainment, etc. This corresponds reasonably well to the concepts of Metropolitan Statistical Areas and Metropolitan Divisions, areas defined by the U.S. Office of Management and Budget based on local commuting patterns. Outside of these officially defined metropolitan areas, NAHB has determined that a county will usually satisfy the model's requirements.

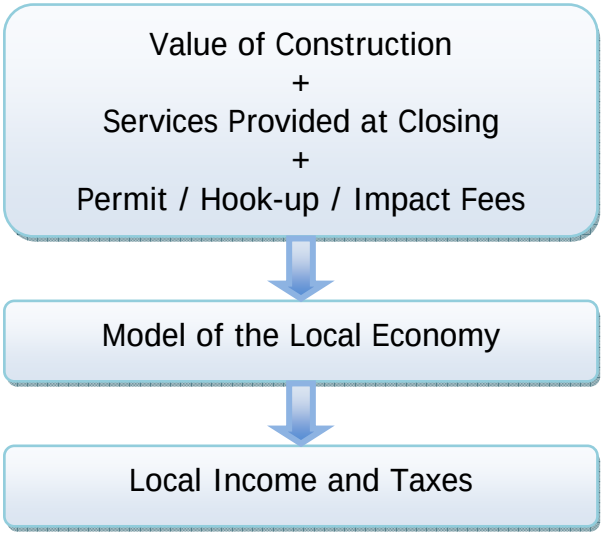
For a particular local area, the model adjusts the indirect business tax section of the national input-output accounts to account for the fiscal structure of local governments in the area. The information used to do this comes primarily from the U.S. Census Bureau's Census of Governments. Wages and salaries are extracted from the employee compensation section of the input-output accounts on an industry-by-industry basis. In order to relate wages and salaries to employment, the model incorporates data on local wages per job published by the Bureau of Economic Analysis.

Phase I: Construction

In order to estimate the local impacts generated by home building, it is necessary to know the sales price of the homes being built, how much raw land contributes to the final price, and how much the builder and developer pay to local area governments in the form of permit, utility connection, impact, and other fees. This information is not generally available from national sources and in most cases must be provided by representatives from the area in question who have specialized knowledge of local conditions.

The model subtracts raw land value from the price of new construction and converts the difference into local wages, salaries, business owners' income, and taxes. This is done separately for all 95 local industries. In addition, the taxes and fees collected by local governments during the construction phase generate wages and salaries for local government employees. Finally the number of full time jobs supported by the wages and salaries generated in each private local industry and the local government sector is estimated.

Summary of Phase I



Phase II: The Construction Ripple

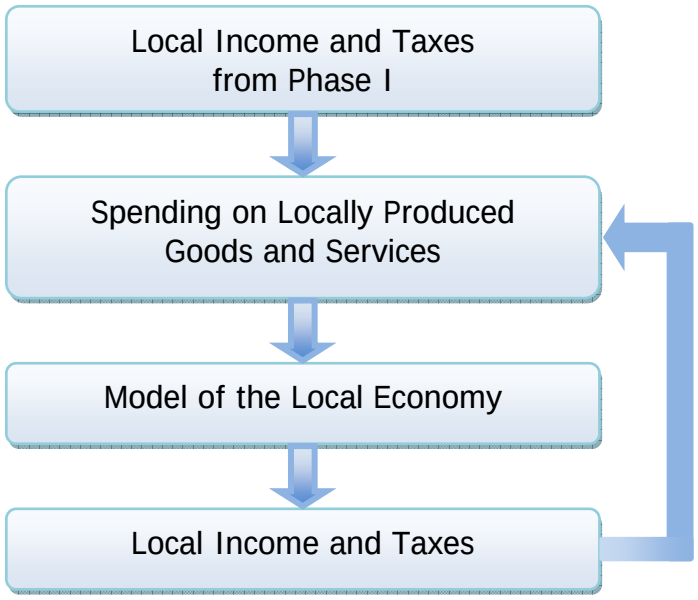
Clearly, the local residents who earn income in Phase I will spend a share of it. Some of this will escape the local economy. A portion of the money used to buy a new car, for example, will become wages for autoworkers that are likely to live in another city, and increased profits for stockholders of an automobile manufacturing company who are also likely to live elsewhere. A portion of the spending, however, will remain within, and have an impact on, the local economy. The car is likely to be purchased from a local dealer and generate income for a salesperson that lives in the area, as well for local workers who provide cleaning, maintenance, and other services to the dealership. Consumers also are likely to purchase many services locally, as well as to pay taxes and fees to local governments.

This implies that the income and taxes generated in Phase I become the input for additional economic impacts analyzed in what we call Phase II of the model. Phase II begins by estimating how much of the added income households spend on each of the local commodities. This requires detailed analysis of data from the Consumer Expenditure (CE) Survey, which is conducted by the U.S. Bureau of Labor Statistics primarily for the purpose of determining the weights for the Consumer Price Index. The analysis produces household spending estimates for 55 local commodities. The remainder of the 87 local commodities enter the model only as business-to-business transactions.

The model then translates the estimated local spending into local business owners' income, wages and salaries, jobs, and taxes. This is essentially the same procedure applied to the homes sold to consumers in Phase I. In Phase II, however, the procedure is applied simultaneously to 56 locally produced and sold commodities.

In other words, the model converts the local income earned in Phase I into local spending, which then generates additional local income. But this in turn will lead to additional spending, which will generate more local income, leading to another round of spending, and so on. Calculating the end result of these economic is a straightforward exercise in mathematics.

Summary of Phase II



Phase III: The Ongoing Impacts

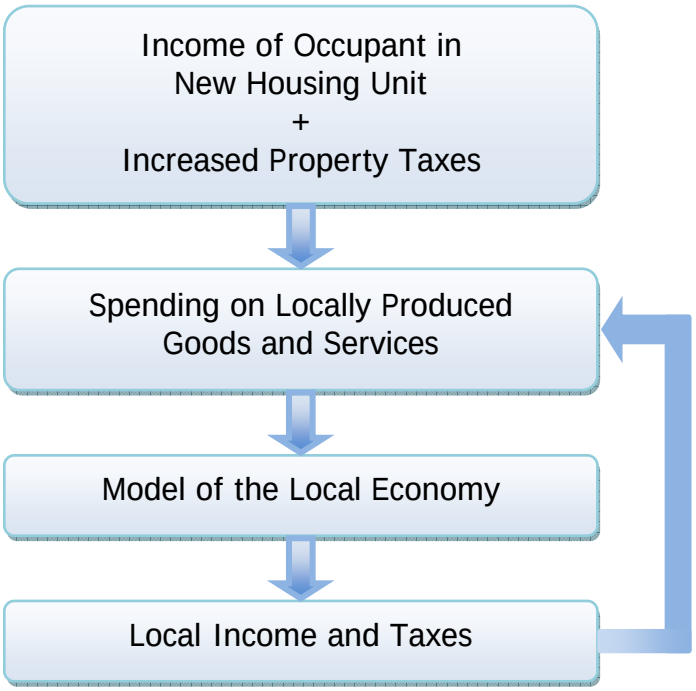
Like Phase II, Phase III involves computing the sum of successive ripples of economic activity. In Phase III, however, the first ripple is generated by the income and spending of a new household (along with the additional property taxes local governments collect as a result of the new structure). This does not necessarily imply that all new homes must be occupied by households moving in from outside the local area. It may be that an average new-home household moves into the newly constructed unit from elsewhere in the same local area, while average existing-home household moves in from outside to occupy the unit vacated by the first household. Alternatively, it may be that the new home allows the local area to retain a household that would otherwise move out of the area for lack of suitable housing.

In any of these cases, it is appropriate to treat a new, occupied housing unit as a net gain to the local economy of one household with average characteristics for a household that occupies a new home. This reasoning is often used, even if unconsciously, when it is assumed that a new home will be occupied by a household with average characteristics—for instance, an average number of children who will consume public education.

To estimate the impact of the net additional households, Phase III of the model requires an estimate of the income of the households occupying the new homes. The information used to compute this estimate comes from several sources, but primarily from an NAHB statistical model based on decennial census data. Phase III of the local impact model then estimates the fraction

of income these households spend on various local commodities. This is done with CE data and is similar to the procedure described under Phase II. The model also calculates the amount of local taxes the households pay each year. This is done with Census of Governments data except in the case of residential property taxes, which are treated separately, and for which specific information must usually be obtained from a local source. Finally, a total ripple effect is computed, using essentially the same procedure outlined above under Phase II.

Summary of Phase III



The details covered here provide a brief description of the model NAHB uses to estimate the local economic benefits of home building. For a more complete description, see the technical documentation at the end of the report. For additional information about the model, or questions about applying it to a particular local area, contact one of the following in NAHB's Housing Policy Department:

David Crowe, Chief Economist (202) 266-8383, dcrowe@nahb.com
Paul Emrath, Assistant Staff Vice President (202) 266-8449, pemrath@nahb.com
Elliot Eisenberg, Senior Economist (202) 266-8398, eeisenberg@nahb.com

Local Impact of Home Building

Technical Documentation for the NAHB Model Used to Estimate Income, Jobs, and Taxes

Paul Emrath,
NAHB Housing Policy Department

June 2009

National Association of Home Builders
1201 15th Street, NW
Washington, DC 20005
202-266-8398

Technical Documentation for the NAHB Model Used to Estimate the Income, Jobs, and Taxes

The Housing Policy Department of the National Association of Home Builders (NAHB) maintains an economic model that it uses to estimate the local economic benefits of home building. The NAHB model is divided into three phases. Phases I and II are one-time effects. Phase I captures the effects that result directly from the construction activity itself and the local industries that contribute to it. Phase II captures the effects that occur as a result of the wages and profits from Phase I being spent in the local economy. Phase III is an ongoing, annual effect that includes property tax payments and the result of the completed unit being occupied.

The model can be customized to a to a specific local economy by replacing key housing market variables. This document explains describes the sources of data used and explains how the estimates are generated.

Modeling a Local Economy

In the NAHB model, a local economy is defined as a collection of industries and commodities, selected from the 2002 benchmark input-output accounts produced by the U.S. Bureau of Economic Analysis (BEA). In these accounts, definitions are based on North American Industry Classification System (NAICS). The most detailed, 6-digit NAICS codes are used in order to parse industries and commodities as precisely as possible in an attempt to include only business and consumer activities that are generally local in nature. As they are adapted by BEA, there are 426 industries in the 2002 benchmark accounts. A complete list can be found in BEA's detailed item output file: http://www.bea.gov/industry/io_benchmark.htm#2002data. The local economy as defined in the NAHB model retains the following 89 industries:

	NAICS	***Detailed Industry Name***
1	111400	Greenhouse and nursery production
2	212320	Sand, gravel, clay, and refractory mining
3	221100	Power generation and supply
4	221200	Natural gas distribution
5	221300	Water, sewage and other systems
6	230101	Nonresidential commercial and health care structures
7	230103	Other nonresidential structures
8	230201	Residential permanent site single- and multi-family structures
9	230202	Other residential structures (primarily dormitories, fraternity and sorority houses)
10	230301	Nonresidential maintenance and repair
11	230302	Residential maintenance and repair
12	323120	Support activities for printing
13	339950	Sign manufacturing
14	420000	Wholesale trade
15	485000	Transit and ground passenger transportation
16	492000	Couriers and messengers
17	493000	Warehousing and storage
18	4A0000	Retail trade

19	511110	Newspaper and publishers
20	515100	Radio and television broadcasting
21	515200	Cable and other subscription programming
22	517000	Telecommunications
23	519100	Other information services
24	518100	Internet service providers and web search portals
25	518200	Data processing, hosting, and related services
26	522A00	Nondepository credit intermediation and related activities
27	523000	Securities, commodity contracts, investments
28	524200	Insurance agencies, brokerages, and related services
29	525000	Funds, trust, and other financial vehicles
30	52A000	Monetary authorities and depository credit intermediation
31	531000	Real estate
32	532100	Automotive equipment rental and leasing
33	532230	Video tape and disc rental
34	532400	Machinery and equipment rental and leasing
35	532A00	General and consumer goods rental except video tapes and discs
36	533000	Lessors of nonfinancial intangible assets
37	541100	Legal services
38	541200	Accounting and bookkeeping services
39	541300	Architectural and engineering services
40	541400	Specialized design services
41	541511	Custom computer programming services
42	541512	Computer systems design services
43	54151A	Other computer related services, including facilities management
44	541800	Advertising and related services
45	541920	Photographic services
46	541940	Veterinary services
47	5419A0	All other miscellaneous professional and technical services
48	561100	Office administrative services
49	561200	Facilities support services
50	561300	Employment services
51	561400	Business support services
52	561600	Investigation and security services
53	561700	Services to buildings and dwellings
54	561900	Other support services
55	562000	Waste management and remediation services
56	611100	Elementary and secondary schools
57	611B00	Other educational services
58	621600	Home health care services
59	621A00	Offices of physicians, dentists, and other health practitioners
60	621B00	Other ambulatory health care services
61	622000	Hospitals
62	623000	Nursing and residential care facilities
63	624400	Child day care services
64	624A00	Individual and family services
65	624200	Community food, housing, and other relief services
66	711100	Performing arts companies
67	711200	Spectator sports

68	712000	Museums, historical sites, zoos, and parks
69	713940	Fitness and recreational sports centers
70	713950	Bowling centers
71	713A00	Amusement parks, arcades, and gambling industries
72	713B00	Other amusement and recreation industries
73	722000	Food services and drinking places
74	811192	Car washes
75	8111A0	Automotive repair and maintenance, except car washes
76	811200	Electronic equipment repair and maintenance
77	811300	Commercial machinery repair and maintenance
78	811400	Household goods repair and maintenance
79	812100	Personal care services
80	812200	Death care services
81	812300	Dry-cleaning and laundry services
82	812900	Other personal services
83	813100	Religious organizations
84	813A00	Grant making and giving and social advocacy organizations
85	813B00	Civic, social, professional and similar organizations
86	S00201	State and local government passenger transit
87	S00202	State and local government electric service
88	S00203	Other state and local government enterprises
89	S00500	General government industry

In contrast to the classification system used in some previous years, single-family and multifamily construction are combined into a single category. The Census Bureau maintains a description of what is included in each NAICS industry on its web site: http://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2002. In BEA's system of input-output accounts, commodities generally conform to industry definitions. However, BEA does not include separate commodities for "state and local government passenger transit" or "state and local government electric service" (these commodities show up as passenger transit and electric service, irrespective of which industry produces them), so the local economy as defined in the NAHB model consists of 89 industries and 87 commodities.

This list includes trade, construction, and a number of industries under the general categories of finance, transportation, and services—but excludes virtually all manufacturing, mining, and agriculture, on the grounds that markets for manufactured products are at least regional—if not national or international—in nature.

The exclusion of many industries is a distinguishing feature of the NAHB local impact model and is consistent with the overall intent of the model: to analyze the impact of locating a housing unit and the household that occupies it in one place rather than another. From this perspective, a house built in Seattle, Washington should not cause additional airplanes to be built or additional software to be produced, even though the occupants of a home built in Seattle may use software produced in Seattle and travel on planes built in Seattle. Because these households would be likely to use these products the same way even if they lived in some other metropolitan area, use of these products is not a function of the home's location and. Hence, industries like software publishing and aircraft manufacturing are excluded from the model.

Based on the industries and commodities described above, a "total local requirements" matrix is constructed that shows the total output required from each of the local industries to produce $1 of each local commodities.

To illustrate the derivation of this matrix, let

$\boldsymbol{c}$ = an 87-element column vector of commodity outputs
$\boldsymbol{g}$ = an 89-element column vector of industry outputs
$\boldsymbol{V}$ = an 87×89 subset of the benchmark make table that shows how much of each commodity is produced by each industry
$\boldsymbol{h}$ = an 89-element column vector showing how much scrap is produced by each industry
$\boldsymbol{U}$ = a 89×87 subset of the benchmark use table that shows how much of each commodity used as an input by each industry. Coefficients for the wholesale trade commodity are set to zero, assuming that these transactions are often non-local in nature. The wholesale trade industry produces a considerable amount of the retail trade commodity. The effect of this is to retain retail trade in the model, irrespective of which industry produces it, but to exclude wholesale trade activities.

The following matrices can then be defined through standard input-output algebra:

$\boldsymbol{B} = \boldsymbol{U}\hat{\boldsymbol{g}}^{-1}$ the direct requirements matrix, showing the amount of each commodity needed as a direct input to produce $1 of each industry's output. (The symbol ˆ indicates a matrix created from a vector by placing the vector=s elements on the matrix diagonal.) This is simply the use table scaled by industry output.

$\boldsymbol{j} = \hat{\boldsymbol{g}}^{-1}\boldsymbol{h}$ a vector showing scrap as a fraction of each industry's output. Many of the elements of this vector are zero in the NAHB local impact model, which excludes most of the manufacturing sector.

$\boldsymbol{D} = \boldsymbol{V}\hat{\boldsymbol{c}}^{-1}$ an 87×89 market share matrix, or the make table scaled by commodity output. $\boldsymbol{D}$ shows the fraction of each commodity (excluding scrap) produced by each industry.

$\boldsymbol{F} = (\boldsymbol{I}-\hat{\boldsymbol{j}})^{-1}\boldsymbol{D}$ an 87×89 matrix showing, for $1 worth of each commodity, the fraction produced by each industry. In short, $\boldsymbol{F}$ is $\boldsymbol{D}$ adjusted for scrap. $\boldsymbol{F}$ is often called a transformation matrix, because it can be used to transform commodities into the output of industries and vice versa.

$$\textit{Total Local Requirements} = \boldsymbol{F}(\boldsymbol{I}-\boldsymbol{B}\boldsymbol{F})^{-1}$$

The total local requirements matrix translates local commodities into the output of local industries. The NAHB model is designed to capture only a fraction of the output: the fraction

that becomes either income for local households or revenue for local governments. These fractions are estimated from a combination of value added components of the input-output tables, plus information taken from other BEA industry accounts. In the BEA accounts, the final price of a commodity is the sum of intermediate outputs plus value added by the industry. Retaining only the value added in each industry from a total requirements matrix avoids double counting and constrains the impact of selling a local commodity to be no more than the total price paid for the commodity.

The input-output accounts decompose value added into three components: compensation of employees, taxes on production and imports, and gross operating surplus. Other BEA industry accounts provide some additional on each component. The following table summarizes the information taken from these accounts that is used to help define a local economy.

	Wages & Salaries per Dollar of Employee Compensation	Wages & Salaries per Full-Time job Equivalents	Other Corporate as a % of Gross Operating Surplus	Other Non-Corp. as a % of Gross Operating Surplus
Farms	86.3%	32,330	27.8%	72.2%
Mining, except oil and gas	77.9%	61,399	62.7%	15.0%
Utilities	70.8%	81,471	71.3%	26.1%
Construction	82.6%	47,736	38.4%	59.9%
Miscellaneous manufacturing	69.9%	49,708	46.0%	52.1%
Wholesale trade	84.3%	61,935	81.4%	15.8%
Retail trade	85.0%	30,328	69.2%	27.3%
Transit and ground passenger transportation	81.1%	27,492	69.8%	26.4%
Other transportation and support activities	80.1%	44,802	57.5%	39.1%
Warehousing and storage	83.7%	39,941	83.3%	15.9%
Publishing industries	81.4%	75,687	80.8%	17.5%
Broadcasting and telecommunications	80.3%	69,858	68.3%	30.2%
Information and data processing services	86.3%	82,011	58.4%	39.8%
Federal Reserve banks, credit intermediation	82.9%	62,017	92.7%	3.8%
Securities, commodity contracts and investments	87.9%	212,191	73.5%	2.6%
Insurance carriers and related activities	82.0%	68,694	86.0%	14.0%
Funds, trusts and other financial vehicles	53.2%	95,698	95.8%	0.0%
Real estate	86.3%	49,838	3.2%	74.9%
Rental leasing services & lessors of intangible assets	85.1%	42,238	64.0%	33.8%
Legal services	86.4%	79,707	19.5%	78.7%
Computer systems design and related services	86.4%	92,108	4.7%	90.8%
Misc. professional, scientific, and technical services	86.1%	69,177	26.1%	72.5%
Administrative and support services	86.2%	32,067	44.8%	52.8%
Waste management and remediation services	85.2%	52,043	75.0%	22.8%
Educational services	86.9%	36,521	53.5%	40.9%
Ambulatory health care services	85.3%	56,174	40.8%	56.7%
Hospitals and nursing and residential care facilities	84.0%	42,062	36.7%	40.4%
Social assistance	87.1%	24,800	42.0%	53.7%
Performing arts, spectator sports, museums	83.5%	73,462	32.0%	66.7%
Amusements, gambling and recreation industries	86.4%	26,113	49.1%	49.4%
Food services and drinking places	86.4%	19,492	68.1%	30.3%
Other services, except government	87.2%	31,983	29.9%	63.6%
State and local general government	76.0%	48,175	NA	NA
State and local government enterprises	77.1%	52,160	NA	NA

In the NAHB model, local income is derived from two of the value-added components: compensation of employees and gross operating surplus, using other information from BEA industry accounts.

Due primarily to data limitations BEA, ratios from the relatively broad categories in the above table are sometimes applied to more narrowly defined local industries, For example, ratios for the broad categories "farms" and "mining" are each applied to a single, more narrowly defined local industry—"greenhouse and nursery production" and "sand, gravel, clay, and refractory mining," respectively.

The estimates of local income in the NAHB model exclude most corporate profits, based on the rationale that ownership of most corporations is national or international in scope. Even if a household living in Cleveland buys a product manufactured by a corporation located in Cleveland, profits derived from the sale are likely to be distributed to shareholders living in other locations.

The model makes an exception to this general rule for subchapter S corporations. S corporations tend to be smaller and more local and in this regard tend to resemble partnerships more than C corporations. S corporations also tend to be relatively common in particular industries, such as residential construction. The Internal Revenue Service (IRS) provides information on business receipts by form of business and industry (http://www.irs.gov/taxstats/bustaxstats/article/0,,id=152029,00.html) and this is used to decompose corporate profits into profits for S-corporations and C-corporations. The IRS tables provide relatively limited industry detail, so again percentages for a broadly defined industry are often applied to several of the more precisely defined 6-digit NAICS industries. The S-corporation profits by industry are then included as part of local income.

Local government revenue is estimated as a function of both local income and taxes on production and imports by industry. Across the country as a whole, BEA's national accounts show that taxes on production and imports collected by local governments (which consist largely of sales taxes) account for 36.1 percent of all TOPI (86.2 percent, for state and local governments are combined), and that the average effective state and local corporate income tax rate is 6.35 percent.

Up to this point, the local economy has been defined based on a technology that is location invariant. The fiscal structure of local governments is known to vary considerably across the country, however. At the stage, the model employs data from the most recent Census of Governments (http://www.census.gov/govs/www/gid2002.html). Census of Governments data are available for each of the roughly 87,000 units of government in the U.S., and these data can be used to customize the structure of local government finances to a particular area.

Aggregating personal taxes and fees over all local (or state and local) governments in the U.S. shows that these taxes and fees sum to 1.031 (4.466) percent of personal income. The NAHB model uses three local (or state and local) factors based on aggregate revenues divided by personal income, and the ratio of these measures for the area in question to the U.S. as a whole.

For a specific area,

Personal taxes =
1.0317% (or 4.446%) × Local Personal Income × Local Factor 1

Business taxes =
36.1% (or 86.2%) × TOPI in Local Industries × Local Factor 2 +
6.35% × Corporate Profits in Local Industries × Local Factor 3

where the three local factors are derived on a case by case basis from data in the most recent Census of Governments. These factors are applied to value added in each local industry. This preserves the industry detail in the input-output accounts while customizing the analysis to a local area by using data from the Census of Governments, which is a distinguishing feature of the NAHB local impact model.

In the case of corporate profits in local industries for a particular metropolitan area or nonmetropolitan county, Local Factor 3 will usually be zero. Very few local governments impose a tax on corporate profits, so this will usually have an impact only when the model is applied to an entire state.

Phase I: Construction

As shown diagrammatically in "Background and a Brief Description of the Model Used to Estimate the Economic Benefits", Phase I of the model feeds the dollar amount of construction and ancillary locally produced items into the income and tax matrices derived from the model total local requirements. Accounting for everything that goes into building a home and delivering it to its customer is more complicated than it may at first appear.

For one thing, the Census Bureau subtracts several items from construction value before providing the numbers to BEA for use in the input-output and related GDP accounts. On new homes built for sale, the Census Bureau subtracts 1.1 percent of the sales price for landscaping, 0.5 percent for appliances, 2.9 percent for realtor and brokers fees, and 2.7 percent for marketing and finance costs. There are equivalent subtractions for custom homes (i.e., homes where the builder functions as a general contractor for a home built on the customer's lot).

However, the landscaping and purchases of appliances and marketing/broker services associated with a newly built home clearly are attributable to the construction of the home. Phase I of the NAHB model therefore accounts for these items as separate purchases of the local construction, retail trade, and real estate industries. For retail trade, only the gross margin of appliance purchases are counted. Gross margins for different types of retailers are available from the Census Bureau's Annual Retail Trade Survey (http://www.census.gov/svsd/www/artstbl.html).

In addition, there are settlement or closing costs associated with transferring property from a builder to the ultimate owner. In a typical case, these costs are shared between buyers and

sellers. Construction value as defined in the input-output accounts includes closing costs if they are paid by the seller, but not the buyer. When the local impact model was first developed, NAHB verified these details with economists at BEA.

In order to estimate both closing costs as a fraction of the home's price and the share of these costs the buyer pays, the NAHB model uses national average data compiled by the U.S. Department of Housing and Urban Development.[6] The share of settlement costs paid for by the buyer for loan origination and discount fees, title and private mortgage insurance, and legal fees are counted as output of the local depository credit intermediation, insurance, and legal services industries, respectively.

Another category of closing costs sometimes paid by the buyer is mortgage or deed transfer taxes. Phase I of the NAHB model does not automatically include an amount for transfer taxes. In most (but not all) instances, these taxes are imposed by state, rather than, local governments. To the extent that transfer taxes apply in a specific case, that information needs to be supplied by the local entity requesting the analysis.

If the local entity requesting an analysis provides information that sales taxes are imposed on construction material and supplies a local sales tax rate, the model captures these taxes as revenue generated for local governments assuming that materials account for 30 percent of the final price of a housing unit. The figure of 30 percent is taken from information reported in the April 2004 *Professional Builder*, which is generally consistent with results from construction cost surveys NAHB has conducted over the years.

Phase II: The Construction Ripple

Phase I of the model translates home building activity into income for local workers and business proprietors, and revenue for local governments. This output serves as the input for Phase II, as part of the local income generated will be spent, generating more income, generating more spending, and so on. These spending ripples damp and eventually converge to a limit, which is the ultimate ripple or multiplier effect.

To convert local income to local spending, the model requires information about local household spending tendencies. Detailed spending information at the household level is available from the Consumer Expenditure (CE) Survey, produced by the U.S. Bureau of Labor Statistics (BLS) primarily for the purpose of determining the weights for the Consumer Price Index (http://www.bls.gov/cex/home.htm) [7]

---

[6] Report to Congress on the Need for Further Legislation in the Area of Real Estate Settlements, 1981, Exhibits II-1 and II-6.

[7] Technically, in the Consumer Expenditure Survey, the unit of measurement is actually not a household, but a *Consumer Unit*, a group of individuals who live in the same house and make joint purchasing decisions. There may be more than one Consumer Unit in a household.

The CE consists of two different types of surveys: 1) an interview survey that collects data on monthly expenditures as well as information on income and household characteristics, and 2) a diary survey that collects data on weekly expenditures of frequently purchased items. These are two separate surveys, each designed individually with weights that aggregate to an estimate of total spending in the U.S. When it estimates aggregate measures of consumer spending, BLS combines results from the two different types of surveys in a manner it does not disclose in detail to the public.

The NAHB local impact model uses only data from the interview survey, primarily to avoid the need for arbitrary decisions about which spending items to take from which survey. Based on its CE interview survey, BLS produces a public use microdata set consisting of quarterly files with household characteristics (including income), another set of quarterly files a record of income and other characteristics for each member of the household, and a set of fifty-one annual "EXPN" files with detailed information about various categories of expenditures.

These detailed files allow NAHB to maintain a conservative approach and exclude spending on items that may often be purchased from a vendor outside the local area. For example, BLS collects information on spending while on trips and vacations away from home in a separate "TRV" EXPN file. The NAHB local impact model does not include any spending information at all from the TRV file. NAHB processes the information from the EXPN files along with information on household characteristics and income to estimate spending tendencies on 47 locally produced commodities, as shown in the following table:

Local Spending Extracted from the CE EXPN Files

	Local commodity	NAICS Code	EXPN File	Description of items included in local spending
1	Greenhouse and nursery production	111400	CRB	Costs of all items and services for planting shrubs or trees, or otherwise landscaping the ground of the housing unit in which the consumer unit lives.
2	Power generation and supply	221100	UTC	Electricity bills for the housing unit in which the consumer unit lives.
3	Natural gas distribution	221200	UTC	Gas bills for the housing unit in which the consumer unit lives.
4	Water, sewage and other systems	221300	UTC	Water and/or sewage bills for the housing unit in which the consumer unit lives.
5	New residential additions and alterations, nonfarm	230130	CRB	Costs of all items and services associated with building an addition to the house or a new structure including porch, garage or new wing; finishing a basement or an attic or enclosing a porch; remodeling one or more rooms; building outdoor patios, walks, fences, or other enclosures, driveways, or permanent swimming pools; or other improvements or repairs to the housing unit in which the consumer unit lives.

	Local commodity	NAICS Code	EXPN File	Description of items included in local spending
6	Maintenance and repair of farm and nonfarm residential structures	230310	CRB	Costs of all items and services associated with repairing outdoor patios, walks, fences, driveways, or permanent swimming pools; inside painting or papering; outside painting; plastering or paneling; plumbing or water heating installations and repairs; electrical work; heating or air-conditioning jobs; flooring repair or replacement; insulation; roofing, gutters, or downspouts; siding; installation, repair, or replacement of window panes, screens, storm doors, awnings, etc.; and masonry, brick or stucco work for the housing unit in which the consumer unit lives.
7	Transit and ground passenger transportation	485000	EDA	Amount paid for private bus transportation to elementary or high school for members of the consumer unit.
			XPB	Costs for taxis, limousine service, and public transportation, except while on a trip.
8	Retail trade	4A0000	APA	Purchases of major appliances × 26.5% (gross margin for electronics and appliance stores) × 81% (adjustment for loss of local sales to internet and mail order business).
			APB	Purchases of other households appliances and other selected items × 26.5% (gross margin for electronics and appliance stores) × 81% (adjustment for loss of local sales to internet and mail order business).
			FRA	Purchases of home furnishings × 48.1% (gross margin for furniture and home furnishing stores) × 81% (adjustment for loss of local sales to internet and mail order business).
			CLA	Purchases of clothing × 47.9% (gross margin for clothing and clothing accessories stores) × 81% (adjustment for loss of local sales to internet and mail order business).
			CLB	Purchases of infants' clothing, watches, jewelry, and hairpieces × 47.9% (gross margin for clothing and clothing accessories stores) × 81% (adjustment for loss of local sales to internet and mail order business).
			CLC	Purchases of sewing materials × 47.9% (gross margin for clothing and clothing accessories stores) × 81% (adjustment for loss of local sales to internet and mail order business).
			OVB	Purchases of automobiles, including down payment and payment of principle on loans × 16.2% (gross margin for automobile dealers) × 81% (adjustment for loss of local sales to internet and mail order business).
			VOT	Purchases of gasoline and other fuels and fluids used in vehicles × 16.4% (gross margin for gasoline stations) × 81% (adjustment for loss of local sales to internet and mail order business).
			IHB	Share of health insurance premiums, after broker/agent share is subtracted, used to purchase prescription drugs and durable medical equipment × 30.8% (gross margin for health and personal care stores) × 81% (adjustment for loss of local sales to internet and mail order business).

	Local commodity	NAICS Code	EXPN File	Description of items included in local spending
	Retail trade (cont)		IHC	Number of persons covered by Medicare times average Medicare benefits per Medicare enrollee times the share of Medicare benefits used to purchase prescription drugs, other nondurable medical products, and durable medical equipment × 30.8% (gross margin for health and personal care stores) × 81% (adjustment for loss of local sales to internet and mail order business).
			MDB	Direct purchases of glasses, hearing aids, prescription medication, convalescent equipment, or other medical equipment × 30.8% (gross margin for health and personal care stores) × 81% (adjustment for loss of local sales to internet and mail order business).
			EDA	Purchases of books or other equipment for elementary or high school for members of the consumer unit × 39.8% (gross margin for sporting goods, hobby, book and music stores) × 81% (adjustment for loss of local sales to internet and mail order business).
			ENT	Amount paid for CDs or audio tapes, photographic film, video cassettes or tapes or discs, and books, but not through a mail order club or subscription × 39.8% (gross margin for sporting goods, hobby, book and music stores) × 81% (adjustment for loss of local sales to internet and mail order business).
			MIS	Expenses for flowers, potted plants, pet supplies and medicines, toys, and games, and computer or video hardware, software, and accessories × 43.8% (gross margin for miscellaneous store retailers) × 81% (adjustment for loss of local sales to internet and mail order business).
			XPA	Expenditure for food and nonfood items at grocery stores, and for food and beverages from places other than grocery stores × 29.4% (gross margin for food and beverage stores).
			XPB	Expenditures for cigarettes and other tobacco products × 31.4% (gross margin for all retailers excluding motor vehicle and parts dealers) × 81% (adjustment for loss of local sales to internet and mail order business).
9	Newspaper and publishers	511110	ENT	Expenses for newspapers and other periodicals not through a subscription.
10	Cable networks and program distribution	513200	UTI	Expenses for cable TV, satellite TV, and satellite radio services.
11	Telecommunications	513300	UTA	Telephone bills, irrespective of items included in service.
			UTP	Pre-paid phone card or public pay phone services.
12	Information services	514100	UTI	Expense for internet connection, excluding any away from home.
13	Nondepository credit intermediation and related activities	522A00	OVB	Interest payment on automobile loans.

	Local commodity	NAICS Code	EXPN File	Description of items included in local spending
14	Insurance agencies, brokerages, and other insurance related activities	524200	INB	Percent of premiums for all types of insurance other than health (percentage based on agent/brokers' share of industry).
			IHB	Percent of premiums for health insurance (percentage based on agent/brokers' share of industry).
15	Monetary authorities and depository credit intermediation	52A000	HEL	Interest paid on lump sum home equity loans, based only on the home in which the consumer unit lives.
			OPH	Interest paid on home equity lines of credit, based only on the home in which the consumer unit lives.
			OPI	Penalty charges on special or lump sum mortgage payment.
			XPB	Charges for safe deposit boxes, checking accounts, and other banking services.
16	Real estate	531000	RNT	Total rental payments for the housing unit in which the consumer unit lives.
			OPI	ground or land rent, portion of condo fee for management services, special payments for property management services--all of these only for the property in which the consumer unit lives.
17	Automotive equipment rental and leasing	532100	RTV	Expenses for renting vehicles.
			LSD	Expenses for leasing vehicles.
18	Video tape and disc rental	532230	ENT	Amount paid for rental of video cassettes, tapes, or discs.
19	General and consumer goods rental except video tapes and discs	532A00	APA	Expenses for renting major appliances.
			APB	Expenses for renting other household appliances and selected items.
			FRB	Expenses for renting furniture.
			CLD	Expenses for renting clothing.
			MDB	Expenses for renting convalescent or other medical equipment.
20	Legal services	541100	MIS	Expenses for services of lawyers or other legal professionals.
21	Accounting and bookkeeping services	541200	MIS	Accounting fees.
22	Photographic services	541920	ENT	Amount paid for film processing or printing digital photographs.
			MIS	Amount paid for professional photography fees.
23	Veterinary services	541940	MIS	Veterinarian expenses for pets.
24	Investigation and security services	561600	MIS	Home security service fees.
25	Services to buildings and dwellings	561700	APA	Charges for installing major appliances.
			EQB	Costs for pest control or repairing and servicing heating and air conditioning equipment.
			MIS	Other home services and small repair jobs around the house.
26	Waste management and remediation services	562000	UTC	Trash/garbage collection bills for the housing unit in which the consumer unit lives.

	Local commodity	NAICS Code	EXPN File	Description of items included in local spending
27	Elementary and secondary schools	611100	EDA	Tuition and other expenses for elementary or high school for members of the consumer unit.
28	Home health care services	621600	IHB	Share of health insurance premiums, after broker/agent share is subtracted, used to pay for home health care.
			IHC	Number of persons covered by Medicare times average Medicare benefits per Medicare enrollee times the share of Medicare benefits used to pay for home health care.
29	Offices of physicians, dentists, and other health practitioners	621A00	IHB	Share of health insurance premiums, after broker/agent share is subtracted, used to pay for physician, clinical, and dental services.
			IHC	Number of persons covered by Medicare times average Medicare benefits per Medicare enrollee times the share of Medicare benefits used to pay for physician, clinical, and dental services.
			MDB	Direct payments for eye care, dental care, or physician services.
30	Other ambulatory health care services	621B00	IHB	Share of health insurance premiums, after broker/agent share is subtracted, used to pay for other professional services.
			IHC	Number of persons covered by Medicare times average Medicare benefits per Medicare enrollee times the share of Medicare benefits used to pay for other professional services.
			MDB	direct payments for services by medical professionals other than physicians, lab tests, and other medical care.
31	Hospitals	622000	IHB	Share of health insurance premiums, after broker/agent share is subtracted, used to pay for hospital care.
			IHC	Number of persons covered by Medicare times average Medicare benefits per Medicare enrollee times the share of Medicare benefits used to pay for hospital care.
			MDB	Direct payments for hospital rooms or services.
32	Nursing and residential care facilities	623000	IHB	Share of health insurance premiums, after broker/agent share is subtracted, used to pay for nursing home care.
			IHC	Number of persons covered by Medicare times average Medicare benefits per Medicare enrollee times the share of Medicare benefits used to pay for nursing home care.
			MDB	Direct payments for care in convalescent of nursing home.
33	Child day care services	624400	EDA	Expenses for nursery school or child day care centers for members of the consumer unit.
			MIS	Expenses for babysitting, nanny services, or child care in the consumer unit's or someone else's home.
34	Performing arts companies	711100	SUB	Theater or concert season tickets.
			ENT	Single admissions to movies, theaters, and concerts.
35	Spectator sports	711200	SUB	Season tickets to sporting events.
			ENT	Single admissions to spectator sporting events

	Local commodity	NAICS Code	EXPN File	Description of items included in local spending
36	Fitness and recreational sports centers	713940	EDA	Recreational lessons and instruction for members of the consumer unit.
			SUB	Expenses for membership in golf courses. Country clubs, health clubs, fitness centers, or other sports and recreational organizations.
			ENT	Fees for participating in sports.
37	Other amusement, gambling, and recreation industries	713A00	MIS	Expenses for lotteries and games of chance.
38	Food services and drinking places	722000	XPA	Expenditures for food and beverages at restaurants, cafeterias, cafes, drive-ins, etc.
39	Automotive repair and maintenance, except car washes	8111A0	VEQ	Expenses for vehicle maintenance and repair.
			VOT	Expenses for towing and automobile repair service policies.
40	Electronic equipment repair and maintenance	811200	EQB	Cost for repairs and services related to computers.
41	Household goods repair and maintenance	811400	EQB	Costs for repairing or servicing appliances, tools, sound, video, photographic, sports, and lawn and garden equipment; or repairing computer-related equipment.
			FRB	Costs for repairing furniture.
			CLD	Costs for repairing or altering clothing and accessories, or repairing watches or jewelry.
42	Personal care services	812100	IHC	Number of persons covered by Medicare times average Medicare benefits per Medicare enrollee times the share of Medicare benefits used to pay for other personal care services.
			MIS	Expenses for adult day care centers, and home care for invalids, convalescents, handicapped, or elderly persons.
43	Death care services	812200	MIS	Expenses for funerals, burials, cremation, and purchase and upkeep of cemetery lots or vaults.
44	Dry cleaning and laundry services	812300	XPB	Expenses for clothing and other items at sent to drycleaners and laundry, as well as coin operated dry cleaning and laundry machines.
45	Other personal services	812900	CLD	Costs of clothing storage services.
			VOT	Fess for vehicle parking, boat docking and plane landing.
			MIS	Catering and pet services.
			XPB	Expenses for haircuts, hair styling, manicures, massages, and other salon services.
46	Religious organizations	813100	CNT	Contributions to religious organizations.
47	Civic, social, professional and similar organizations	813B00	SUB	Expenses for membership in civic, service, or fraternal organizations.

For the items included in retail sales, only the gross margins are included, and in most cases a further adjustment is made to account for loss of local sales to internet and mail order business. The fraction is based on the *Report on Sales Taxes* produced by the Government Accountability Office (GAO) in June of 2000 (GAO/GGD/OCE-00-165). Using numbers from Marketing

Logistics, GAO estimated that business-to-consumer remote sales in 2000 were 186 to 278 billion. A subsequent GAO update found no need to revise the analysis (March 28, 2002 press release). NAHB applied this sales loss estimate to personal consumption expenditures on durable and non durable goods from the GDP accounts in order to derive the factor used to deflate purchases and account for business local retailers lose due to remote sales through media such as the internet.

Insurance payments are separated into a share going to brokers and agents and the insurance companies, based on the proportional share of revenue reported in the latest Economic Census (http://www.census.gov/econ/census02/data/us/US000_52.HTM). The share going to brokers and agents is counted as local income. However, it is also assumed that the share going to insurance companies comes back in some cases as these companies pay medical costs for policy holders that go to health care providers in the local area. This is estimated using "Personal Health Care Expenditures by object & Source of Payment" reported by the Census Bureau in the *Statistical Abstract of the United States* (Table 128 in the 2008 Abstract).

A similar calculation is made for expenses covered by Medicare. The CE data include the number of household members covered by Medicare. Payments made by Medicare to local health care providers are estimated using statistics on "Medicare Benefits by Types of Provider," "Medicare Enrollees," and "Medicare Disbursements by Type of Beneficiary" (Tables 134, 136 and 137, respectively in the 2008 *Statistical Abstract of the United States*)

The consumer spending variables used in the model are all in the form of average propensities to consume—that is, average fractions of before-tax income spent on various items. As shown in the table above, The EXPN files generate local consumer spending estimates for 47 of the first 85 local commodities listed on pages 2 and 3. The others enter the model only through local business-to-business transactions in the local total requirements matrix.

To this, the local impact model adds seven categories of local commodities produced by local government enterprises:

1 Local government electric service
2 Local government natural gas distribution
3 Local government water & sewerage
4 Local government passenger transit
5 Local government liquor stores
6 Local government sanitary services
7 Local government hospitals

The introduction of these commodities does not increase total local spending. Instead, as each of these seven commodities has a corresponding commodity produced by private sector industry, the local impact model allocates consumption spending between the publicly produced and privately produced commodities based on information from the Census of Governments. This enables the model to be consistent with both national household consumption patterns and revenue collected by all government enterprises in a particular local area.

To this is added one other local commodity, general government, to account for tax and fee payments (computed in Phase II primarily from BEA personal income estimates and Census of Governments revenue data).

The results can be collected in a matrix 2×55 matrix, $\boldsymbol{A}$:

$$\boldsymbol{A} = \begin{bmatrix} a_1 & a_2 & a_3 & \cdots & a_{54} & 0 \\ 0 & 0 & 0 & \ldots & 0 & 1 \end{bmatrix}$$

The elements in the first row of $\boldsymbol{A}$ show the average fraction of income spent on each of the 54 local commodities (including those produced by local government enterprises such as publicly owned utilities or hospitals). The "O"s and "1" in the second row indicates that no taxes are spent directly by the household on any of the first 54 commodities; 100 percent is spent on the local general government commodity. This two-row structure is designed to align with the output from Phase I of the model, which comes in the form of before-tax local income and local tax estimates.

Several other matrices and vectors derived from the above concepts are needed to calculate the Phase II ripple or multiplier effect:

$\boldsymbol{W}$: a 55×89 matrix that translates local commodities into local income,

$\boldsymbol{G}$: a 55×89 matrix that translates local commodities into local government general revenue collected from persons, and

$\boldsymbol{T}$: a 55×89 matrix that translates local commodities into local government general revenue collected from businesses

$\boldsymbol{L} = \begin{bmatrix} \boldsymbol{W} & \boldsymbol{G} & \boldsymbol{T} \end{bmatrix}$ therefore defines a 55×267 matrix

$\boldsymbol{x}$ = a two element column vector containing local income and local taxes generated in Phase I

$$\boldsymbol{Y} = \begin{bmatrix} \boldsymbol{i} & \boldsymbol{0} & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{i} & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{i} \end{bmatrix}$$ a 267×3 matrix where $\boldsymbol{i}$ is a 89-element unit column vector,

$$\boldsymbol{Z} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 1 \end{bmatrix}$$

In summary, x is the income and tax output from Phase 1, A translates income and taxes into spending on particular commodities, L translates the detailed commodity spending into income and taxes in each of 89 local industries, and Y and Z are technical devices for summing results. Y collapses the components of a 267-element vector into a 3-element vector of income, personal taxes, and business taxes. Z converts a 3-element vector of this form into a 2-element income and tax vector.

The row vector defined as $x'A$ shows how much, in dollar terms, people who earn income during Phase I spend on each of the 55 local commodities, including local government.

The calculation $x'ALYZ$ produces a 2-element local income and local tax vector of the same form as x'. Postmultiplying a vector of this type by $ALYZ$ will always produce a similar, 2-element income and tax vector. Either by construction, or by checking that both eigenvalues are smaller than 1, it is possible to show that $ALYZ$ is a contracting matrix. This implies that the rounds below show successively smaller increments of income and taxes added to the local economy:

$$\begin{aligned}
&\textit{Round } 0: \; x' \\
&\textit{Round } 1: \; x'ALYZ \\
&\textit{Round } 2: \; x'ALYZ\,ALYZ \\
&\textit{Round } 3: \; x'ALYZ\,ALYZ\,ALYZ \\
&\qquad\vdots \\
&\textit{Round } K: \; x'\prod_{k=1}^{K} ALYZ
\end{aligned}$$

The terms of this sequence can be summed in the usual manner to create an infinite series. Because $ALYZ$ is a contracting matrix, the result is a convergent series, the limit of which is

$$x'\,[I-ALYZ]^{-1}$$

This is the final multiplied effect on local income and local taxes at the end of Phase II. The factor $[I-ALYZ]^{-1}$ is a matrix version of the conventional Keynesian spending multiplier. Because x' is reported in Phase I, it is subtracted from the effect reported in Phase II.

For some purposes, especially estimating employment impacts, we are interested in tracking income in Phase II by industry. Calculations to accomplish this are based on the following sequence of 1×267 vectors:

$$\begin{aligned}
&\textit{Round } 1: \; x'AL \\
&\textit{Round } 2: \; x'AL\,YZAL \\
&\qquad\vdots \\
&\textit{Round } K: \; x'AL\prod_{k=1}^{K-1} YZAL
\end{aligned}$$

Note that sequence begins with the spending vector $x'AL$—that is, it excludes the income and taxes that have already been captured in Phase I. The limit of the series defined based on this sequence is

$$x'AL\,[I-YZAL\,]^{-1}$$

This is a 267-element row vector, the first 89 elements containing the final, multiplied effect on local income by industry generated during Phase II. As explained above, income by industry can be separated into business owners' income and wages and salaries, and the wages and salaries converted to full-time job equivalents.

From the standpoint of local governments, it may be desirable to track individual sources of revenue, such as particular fees and taxes. To facilitate this, it is useful to have a three element local income and local tax vector, where the tax revenue is decomposed into taxes collected from persons and taxes collected from businesses.

Consider the following sequence of such 3-element vectors:

$$\begin{aligned} &Round\ 1: \ x'ALY \\ &Round\ 2: \ x'ALY\ ZALY \\ &\qquad\vdots \\ &Round\ K: \ x'ALY\ \prod_{k=1}^{K} ZALY \end{aligned}$$

This sequence begins after *Round 0*, implicitly excluding income earned and taxes paid during Phase I. The limit of the infinite series defined by this sequence is

$$x'ALY\,[I-ZALY]^{-1}$$

This is the final, multiplied effect on local income, local government revenue collected from persons, and local government revenue collected from businesses in Phase II of the model. The tax structure for a particular local area, derived primarily from Census of Governments data as described above, can be applied to this result in order to decompose local government revenue into particular types of taxes and fees.

Phase III: The Ongoing Impacts

A distinguishing feature of the NAHB technique for estimating local impacts is the way it models characteristics and behavior of new housing unit occupants, depending on the particular type of unit being built. There are six basic variants of the NAHB model designed to accommodate different varieties of residential construction:

1. Generic Single-Family
2. Generic Multifamily
3. Active Adult
4. Family Low-Income Housing Tax Credit (LIHTC)
5. Elderly LIHTC
6. Remodeling

The remodeling version of the model does not in general incorporate ongoing impacts, so it requires no occupant income estimates. For the other five versions of the model, separate occupant income estimates are derived in a way that vary with location as well as with the type of units being built. The derivations are based on relationships between average income and standard variables that are typically available at the local level. The methods for establishing these relationships are summarized below.

Generic Single-Family. Regression of average income of home owners on area median family income and average value of the units using American Community Survey (ACS) microdata.

Generic Multifamily. Regression of average income of home owners on area median family income and average rent using ACS microdata.

Active Adult. Average income of movers into age-restricted owner occupied units and average income of all home buyers are computed from American Housing Survey (AHS) microdata the , and the ration of the two average incomes is formed/

Family LIHTC. Average incomes of all movers into rental units who have less than 60 percent of median family income for the U.S. as a whole, computed from CE data.

Elderly LIHTC. Average incomes of all elderly movers into rental units who have less than 60 percent of median family income for the U.S. as a whole, computed from CE data.

The ACS is the Census Bureau's replacement for the decennial Census long form (http://www.census.gov/acs/www/). The AHS, funded by the U.S. Department of Housing and Urban Development (HUD) and conducted by the Census Bureau, is the federal government's primary vehicle for collecting detailed information about housing units and their occupants at the national level (http://www.huduser.org/datasets/ahs.html).

The ratios and regression results listed above allow the model to be simultaneously customized to a particular area and a particular type of construction by inputting specific local information that is generally available. When customizing to a local area, median family income for that particular area is used. HUD produces median income estimates for all parts of the country in a timely fashion as part of the process it uses to establish income limits for various housing programs (http://www.huduser.org/datasets/il.html).

When it is necessary to translate rents into value or vice versa, a cap rate taken from the

Residential Finance Survey (http://www.huduser.org/datasets/rfs.html), also funded by HUD and conducted by the Census Bureau, is used.

In addition to average income, estimated spending tendencies for movers into each type of construction are needed. Separate spending vectors are estimated for each using household information available in the CE data. The table on the following page shows average local propensities to consume computed from the 2006 CE.

This modeling of average spending by different types of households soon after they move in is another distinguishing feature of the NAHB local impact model. In addition to the function they serve in the local model, average spending tendencies computed from CE data have also proven to be of interest for their implications at the national level.[8]

This modeling of average spending by different types of households soon after they move in is another distinguishing feature of the NAHB local impact model. In addition to the function they serve in the local model, average spending tendencies computed from CE data have also proven to be of interest for their implications at the national level.[9]

Compared to home buyers, renters tend to spend more of their incomes locally—partly due to the tendency of lower-income households to spend a greater fraction of their incomes on necessities, but also due to rental payments that go to a local owner, or owner employing a management company with a local presence. The equivalent housing expense for a home buyer would be a mortgage payment. Because mortgage payments typically are made to non-local owners of the mortgage through non-local servicers, they are excluded from the spending estimates in the NAHB local impact model.

Average propensities to spend on virtually all categories of local health care services are higher for households moving into construction designed for older residents (age-restricted active adult and elderly LIHTC).

As was described in Phase II, seven categories of commodities produced by local government enterprises are added to the model, and a share of local spending (which may be zero) is allocated to these enterprises instead of private producers based on revenues reported in the Census of Governments for each local government enterprises in the area.

Also as in Phase II, Census of Governments data are used to estimate most categories of tax and fee revenue generated for general (non-enterprise) governments in the area. The exemption is residential property taxes. Perhaps surprisingly, residential and non-residential property taxes are not reported separately. Moreover, some states have restriction on rate increases of other laws that tend to make property tax rates different on new construction. Particular developments (for example, those financed by the LIHTC program) may also be granted special forms of property tax relief.

---

[8] See, for example, the October Special Study in *Housing Economics*: "Spending Patterns of Home Buyers." http://www.nahb.org/generic.aspx?sectionID=734&genericContentID=106491&channelID=311

[9] See, for example, the October Special Study in *Housing Economics*: "Spending Patterns of Home Buyers." http://www.nahb.org/generic.aspx?sectionID=734&genericContentID=106491&channelID=311

Example of Average Local Spending Computed from CE Data

	Output of industry purchased locally	All House-holds	New Home Buyers	New Multifamily Renters	Active Adult Buyers	New Family LIHTC	New Elderly LIHTC
1	Greenhouse and nursery production	0.157%	0.481%	0.000%	1.052%	0.002%	0.000%
2	Power generation and supply	2.998%	2.802%	0.014%	3.979%	0.014%	0.000%
3	Natural gas distribution	1.634%	1.266%	0.000%	1.609%	0.000%	0.000%
4	Water, sewage and other systems	0.701%	0.728%	0.000%	1.011%	0.000%	0.000%
5	Residential permanent site construction	2.095%	1.962%	1.699%	4.289%	0.003%	0.008%
6	Residential maintenance and repair	1.455%	1.218%	0.021%	2.752%	0.055%	0.048%
7	Transit and ground passenger transportation	0.225%	0.018%	0.100%	0.026%	0.795%	0.723%
8	Retail trade	12.321%	9.591%	13.058%	12.455%	17.559%	14.564%
9	Newspaper and publishers	0.050%	0.026%	0.021%	0.029%	0.103%	0.082%
10	Cable and other subscription programming	0.893%	0.589%	0.833%	0.998%	1.337%	1.336%
11	Telecommunications	3.956%	2.721%	3.156%	3.476%	5.937%	4.753%
12	Internet service providers and web search portals	0.149%	0.127%	0.209%	0.168%	0.191%	0.062%
13	Nondepository credit intermediation and related	0.621%	0.722%	0.566%	0.630%	0.565%	0.222%
14	Insurance agencies, brokerages, and related	0.473%	0.408%	0.364%	0.568%	0.389%	0.395%
15	Monetary authorities and depository credit	0.611%	0.804%	0.132%	0.941%	0.081%	0.059%
16	Real estate	8.088%	1.250%	23.185%	1.092%	34.079%	35.198%
17	Automotive equipment rental and leasing	1.021%	2.148%	0.250%	0.877%	0.195%	0.102%
18	Video tape and disc rental	0.090%	0.086%	0.147%	0.124%	0.129%	0.032%
19	General and consumer goods rental	0.042%	0.014%	0.004%	0.010%	0.074%	0.035%
20	Legal services	0.306%	0.161%	0.644%	0.191%	0.237%	0.001%
21	Accounting and bookkeeping services	0.124%	0.120%	0.096%	0.233%	0.178%	0.296%
22	Photographic services	0.076%	0.094%	0.050%	0.065%	0.073%	0.010%
23	Veterinary services	0.251%	0.191%	0.093%	0.250%	0.123%	0.170%
24	Investigation and security services	0.018%	0.036%	0.000%	0.050%	0.003%	0.001%
25	Services to buildings and dwellings	0.268%	0.295%	0.079%	0.575%	0.061%	0.100%
26	Waste management and remediation services	0.219%	0.247%	0.000%	0.323%	0.000%	0.000%
27	Elementary and secondary schools	0.232%	0.291%	0.043%	0.255%	0.291%	0.000%
28	Home health care services	0.619%	0.255%	0.310%	0.987%	1.047%	3.004%
29	Offices of physicians, dentists, etc.	3.440%	2.515%	3.049%	6.274%	4.172%	10.280%
30	Other ambulatory health care services	0.708%	0.540%	0.372%	1.154%	0.756%	1.876%
31	Hospitals	3.295%	2.125%	1.774%	6.774%	3.001%	9.707%
32	Nursing and residential care facilities	1.383%	0.539%	0.656%	2.098%	2.233%	6.421%
33	Child day care services	0.258%	0.395%	0.315%	0.044%	0.342%	0.000%
34	Performing arts companies	0.220%	0.184%	0.397%	0.225%	0.307%	0.118%
35	Spectator sports	0.084%	0.060%	0.145%	0.045%	0.114%	0.021%
36	Fitness and recreational sports centers	0.423%	0.617%	0.307%	1.136%	0.223%	0.215%
37	Other amusement and recreation industries	0.113%	0.064%	0.019%	0.159%	0.483%	0.862%
38	Food services and drinking places	3.777%	2.979%	4.791%	3.847%	5.381%	2.685%
39	Automotive repair and maintenance	1.690%	1.226%	1.478%	1.278%	1.950%	1.009%
40	Electronic equipment repair and maintenance	0.038%	0.035%	0.057%	0.066%	0.024%	0.053%
41	Household goods repair and maintenance	0.159%	0.138%	0.021%	0.305%	0.042%	0.053%
42	Personal care services	0.757%	0.367%	0.344%	1.520%	1.231%	3.574%
43	Death care services	0.233%	0.059%	0.000%	0.180%	0.055%	0.057%
44	Dry cleaning and laundry services	0.387%	0.119%	0.184%	0.123%	1.297%	1.035%
45	Other personal services	0.239%	0.163%	0.145%	0.286%	0.217%	0.053%
46	Religious organizations	0.828%	0.943%	0.668%	1.573%	0.630%	1.033%
47	Civic, social, professional and similar organizations	0.022%	0.005%	0.008%	0.008%	0.011%	0.024%

For these reasons, when customizing the local impact model to a specific area, information about property taxes on the units being built must be supplied by the entity requesting the analysis. Phase III of the model counts only property tax on the value of construction, assuming that the raw land would be taxed at the same rate if not developed.

Multifamily Phase III impacts are reduced to account for vacant units. By default, the single-family version of the model assumes that units are intended for owner-occupancy and have negligible vacancies. In the Census Bureau's Housing Vacancy Survey (HVS: http://www.census.gov/hhes/www/housing/hvs/hvs.html) homeowner vacancy rates are usually in the neighborhood of only one percent.

For multifamily units, the average multifamily rental annual vacancy rate over the prior decade and average annual multifamily homeowner vacancy rate over the prior decade are used, depending on whether the units are condominiums or rental apartments. In other respects, Phase III treats condo buyers the same as single-family home buyers (the income and spending tendencies discussed above being based on buyers of owner-occupied housing units, irrespective of structure type).

Although vacancy rates are known to fluctuate, the model estimates annual ongoing impacts that are expected to persist for an extended period, so a long-term "natural" measure of vacancy rates is more appropriate for Phase III than a very current, possibly anomalous, number. The reduction for vacancies is applied to all Phase III multifamily impacts except for property taxes, which are assumed to be paid by the owner of the property, whether the units are occupied or not.

Local spending and taxes (including fees and charges paid to local government entities) generate income for local residents, and this income will be spent and recycled in the local economy, much as in Phase II of the model.

Let $\boldsymbol{x}_{\mathrm{n}}$ denote the initial income and tax column vector for new home occupants, $\boldsymbol{A}_{\mathrm{n}}$ denote the matrix formed from the consumption spending patterns of new home occupants, and otherwise maintain the notation used in Phase II of the model. Then consider the following sequence:

$$\begin{aligned}
&\textit{Round } 0: \ \boldsymbol{x_n'} \\
&\textit{Round } 1: \ \boldsymbol{x_n' A_n LYZ} \\
&\textit{Round } 2: \ \boldsymbol{x_n' A_n LYZ\ ALYZ} \\
&\textit{Round } 3: \ \boldsymbol{x_n' A_n LYZ\ ALYZ\ ALYZ} \\
&\qquad\qquad \vdots \\
&\textit{Round } K: \ \boldsymbol{x_n' A_n LYZ} \prod_{k=1}^{K} \boldsymbol{ALYZ}
\end{aligned}$$

The sum of these terms forms an infinite series that converges to the limit

$$\boldsymbol{x_n'\ [I+(A_n - A)LYZ][I-ALYZ]^{-1}}$$

When results are reported for Phase III the income earned by the occupants is subtracted from the final multiplied effect, so that only income generated for occupants of housing units already existing in the area is counted.

Note that, were new home occupants to spend the same fraction of their incomes on the various local commodities as average households, $A_n = A$ and the formula would simplify to

$$x_n' \, [I - ALYZ]^{-1}$$

The formula that produces a 267-element vector, the first 89 of which contain the added income by industry, for Phase III is

$$x_n' \, A_n L \, [I - YZAL]^{-1}$$

Again, the income in each industry can be disaggregated into business owners' income and wages and salaries, and the wages and salaries converted to full time jobs. These exclude any jobs filled by occupants of the new housing units.

The formula that produces a 3-element vector showing the final, multiplied effect on local income, local government general revenue from persons, and local general government revenue from business generated in Phase III is

$$x_n' \, A_n LY \, [I - ZALY]^{-1}$$

As in Phase II, the last two elements of the final 3-element vector can be disaggregated to show revenue generated by particular types of taxes, fees, and charges. The primary difference in Phase III is that the increase in residential property tax revenue (which is introduced into the model as a separate input independent of the Census of Government computations) needs to be subtracted before the decomposition procedure can be applied.

Final Notes

All of the matrix operations in the NAHB local impact model are performed using the O-Matrix package provided by Harmonic Software. The O-Matrix code used to generate Phase III impacts for single-family construction in 2005, and the code used to compute a local total requirements matrix the 1997 BEA input-output accounts are shown as examples of the use of the O-Matrix package on the Harmonic Software web site (http://www.omatrix.com/userstories.html).

The technical documentation on the NAHB model used to estimate the local income, jobs, and taxes generated by home building was prepared by Paul Emrath, Assistant Staff President of Housing Policy Research. For questions on the technical documentation, or on NAHB's impact of home building models in general, he may be contacted in NAHB's Housing Policy Department by phone at 202-266-8449, or by email at pemrath@nahb.com.

The Local Impact of Home Building in a Typical Metro Area

Comparing Costs to Revenue for Local Governments

Prepared by the
Housing Policy Department

June 2009

National Association of Home Builders
1201 15th Street, NW
Washington, DC 20005
202-266-8398

Introduction

Home building generates local economic impacts such as income and jobs for local residents, and revenue for local governments. It also typically imposes costs on local governments—such as the costs of providing primary and secondary education, police and fire protection, and water and sewer service. Not only do these services require annual expenditures for items such as teacher salaries, they typically also require capital investment in buildings, other structures, and equipment that local governments own and maintain.

This report presents metro area estimates of the impacts of home building in a typical metropolitan area, with values of land and new housing units, local taxes, and local government expenses per household set equal to national averages. The averages for taxes and local government spending are based on most of the 87,000-plus local governments in the U.S. Separate estimates are shown for 100 single-family housing units and 100 rental apartments.

The local economic benefits generated by that level of construction are described in a separate report, *The Local Impact of Home Building in a Typical Metro Area: Income, Jobs, and Taxes Generated*. This report presents estimates of the costs—including current and capital expenses—that new residential construction impose on jurisdictions in the area and compares those costs to the revenue generated.

The general approach is to assume local jurisdictions supply new homes with the same services that they currently provide, on average, to occupants of existing homes in the area. These costs can be compared to the revenue generated to answer the question of whether or not, from the perspective of local government, residential development pays for itself.

In the typical case shown here, residential construction pays for itself and begins generating surplus revenue for local governments in the area after only a few years. Average-valued housing units generate more than enough revenue to cover current government expenses in a given year. The surplus accumulates fast enough so that, even if local government undertakes all capital investment before the homes are built, it can be used to pay off the debt by the end of the second year for single family, and by the end of the tenth year for rental apartments.

If single-family and rental apartment development are analyzed jointly, so that the excess of revenue over costs from single-family construction can be used to pay off debt associated with providing infrastructure for apartment tenants, the debt can be paid off by the end of the third year. This is a somewhat more realistic scenario, as governments do not typically provide separate infrastructure for residents, depending on the type of structure they live in. On the other hand, many more single-family units than rental apartments are built in most places in a typical year. In that case, the overall economic impacts on local governments will tend to resemble the single-family impacts.

Moreover, multifamily construction in many places consists of a combination of rental apartments and condominiums. Because condominiums tend to have high value per unit relative to rental apartments, they also tend to generate more property taxes and have a stronger positive impact on local government revenue, without a corresponding increase in the cost of providing services (based on national averages, condominiums do not contain any more school-aged children per unit, for example).

In the current housing market, however—when condominium production has been hit particularly hard by the downturn and many government agencies are trying to restart affordable housing projects that stalled when financing options disappeared—rental apartments represent a leading case of particular interest.

Costs Compared to Revenue: Single-Family Construction

This section summarizes results for single-family construction only. The relevant assumptions about the single-family homes built (including their average price, property tax payments, and construction-related fees incurred) are described in *The Local Impact of Home Building in a Typical Metro Area: Income, Jobs and Taxes Generated*.

- In the first year, 100 single-family homes built in a typical metro area result in an estimated
  - **$2.6 million** in tax and other revenue for local governments,[1]
  - **$227,000** in current expenditures by local government to provide public services to the net new households at current levels, and
  - **$2.3 million** in capital investment for new structures and equipment undertaken by local governments

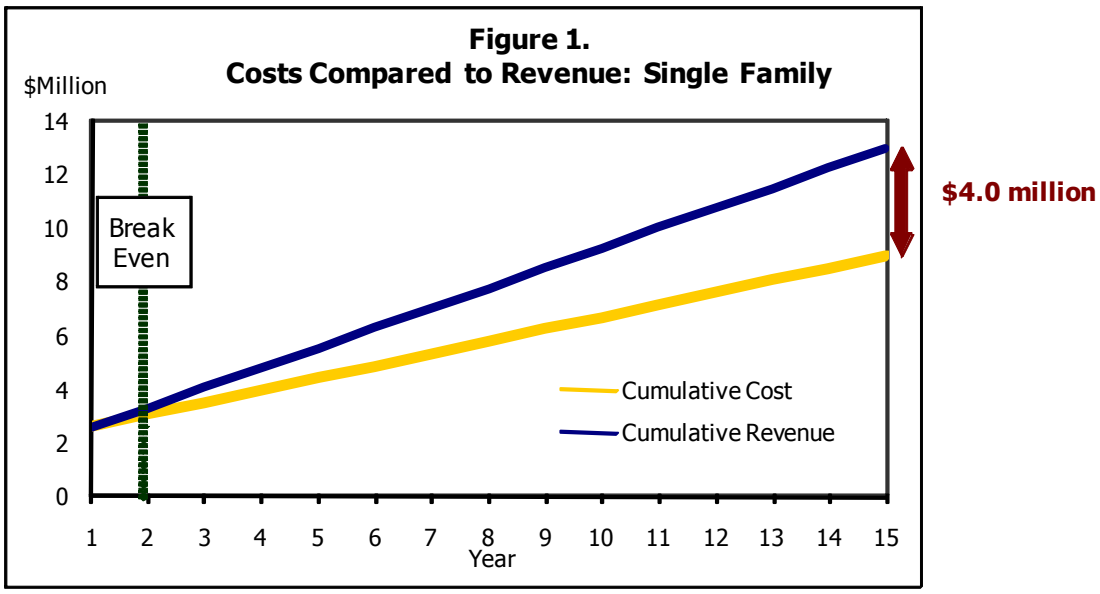
  The analysis assumes that local governments finance the capital investment by borrowing at a current municipal bond rate of 4.40 percent.[2]

- In a typical year after the first, the 100 single-family homes result in
  - **$743,000** in tax and other revenue for local governments, and
  - **$453,000** in local government expenditures needed to continue providing services at current levels.

- The difference between government revenue and current expenditures is defined as an "operating surplus." If is assumed that the operating surplus is used first to service and then to pay down the debt, all debt incurred by investing in structures and equipment at the beginning of the first year can be entirely paid off by the end of the second year. After that, the operating surpluses will be available to finance other projects or reduce taxes. After 15 years, the homes will generate a cumulative **$13.0 million in revenue** compared to only **$9.0 million in costs**, including annual current expenses, capital investment, and interest on debt (Figure 1).

[1] This assumes that homes are occupied at a constant rate during the year, so that the year captures one-half of the ongoing, annual revenue generated as the result of increased property taxes and the new residents participating in the local economy.

[2] The analysis assumes that there is currently no excess capacity, that local governments invest in capital before the homes are built, and that no fees or other revenue generated by construction activity are available to finance the investment, so that all capital investment at the beginning of the first year is financed by debt. This is a conservative assumption that results in an upper bound estimate on the costs incurred by local governments. For information about the particular interest rate on municipal bonds used, see page 2 of the technical appendix.



Costs Compared to Revenue: Rental Apartment Construction

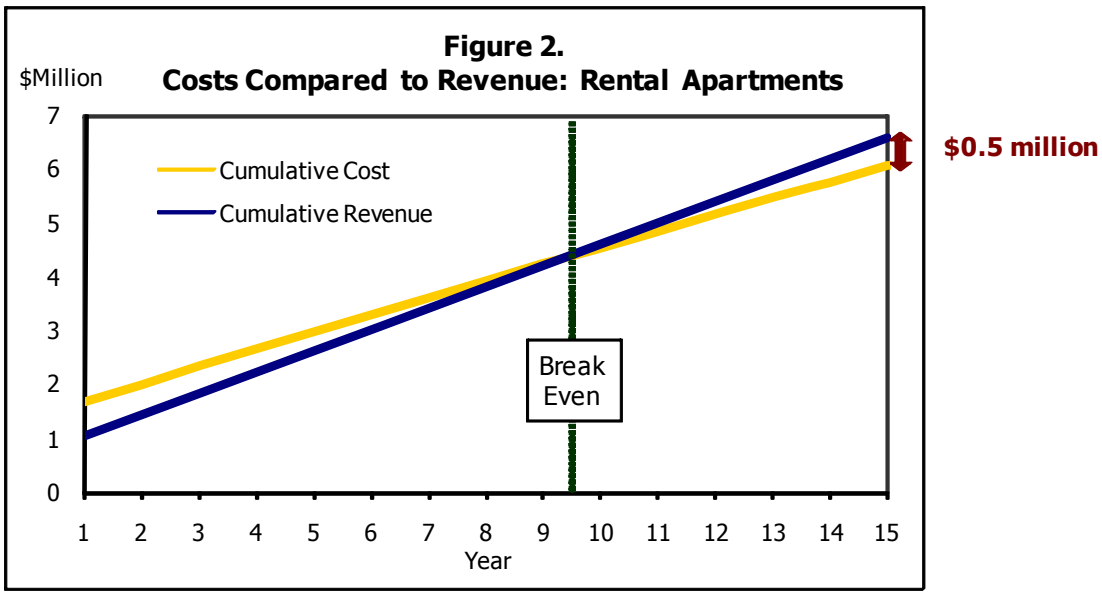
This section summarizes results for rental apartments only. As with the section on single-family construction, relevant assumptions about the units built can be found in *The Metro Area Impact of Home Building in a Typical Metro Area: Income, Jobs and Taxes Generated*.

- In the first year, 100 rental apartments built in a typical metro area result in an estimated
  - **$1.0 million** in tax and other revenue for local governments,
  - **$152,000** in current expenditures by local government to provide public services to the net new households at current levels, and
  - **$1.4 million** in capital investment for new structures and equipment undertaken by local governments

  The analysis assumes that local governments finance the capital investment by borrowing at the current municipal bond rate.

- In a typical year after the first, the 100 rental apartments generate
  - **$395,000** in tax and other revenue for local governments, and
  - **$303,000** in local government expenditures needed to continue providing services at current levels.

- The difference between government revenue and current expenditures is defined as an "operating surplus." If it is assumed that the operating surplus is used first to service and then to pay down the debt, all debt incurred by investing in structures and equipment at the beginning of the first year can be entirely paid off by the end of the tenth year. After that, future operating surpluses will be available to finance other projects or reduce taxes. After 15 years, the apartments will generate a cumulative **$6.5 million in revenue** compared to **$6.0 million in costs**, including annual current expenses, capital investment, and interest on debt (Figure 2).



Costs Compared to Revenue: Both Structure Types

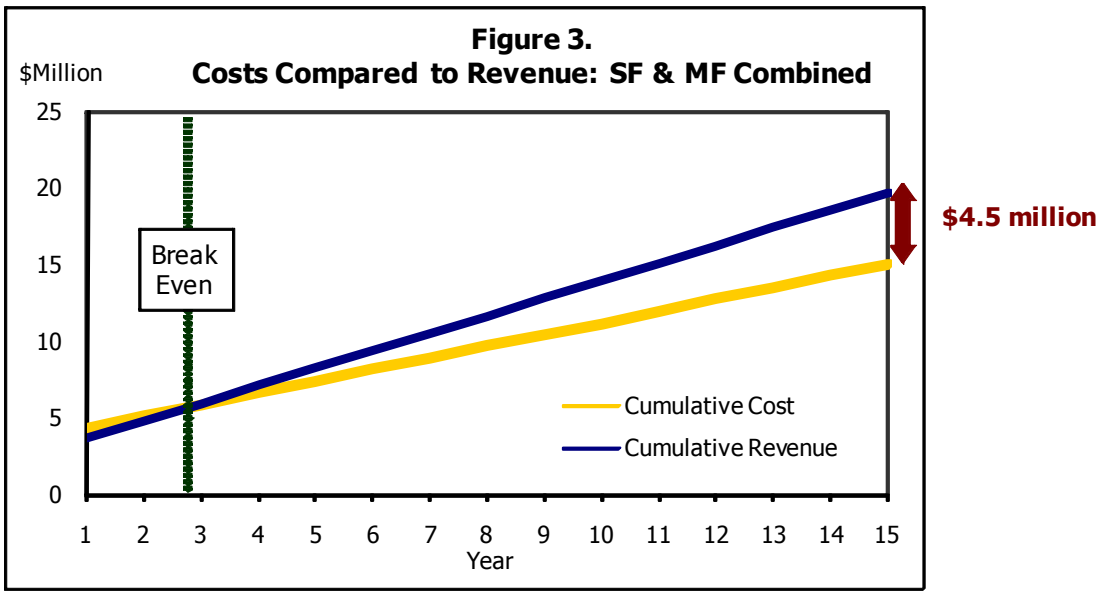
This section summarizes the results for the combined case that analyzes single-family and rental apartment construction jointly. Under this scenario, the joint operating surplus can be used to avoid interest costs that would be incurred in years when one type of construction analyzed in isolation is generating positive reveue net of costs while the other is not.

- In the first year, 100 single-family homes and 100 rental apartments built in a typical metro area result in an estimated
  - **$3.6 million** in tax and other revenue for local governments,
  - **$378,000** in current expenditures by local government to provide public services to the net new households at current levels, and
  - **$3.7 million** in capital investment for new structures and equipment undertaken by local governments

  The analysis assumes that local governments finance the capital investment by borrowing at a current municipal bond rate.

- In a typical year after the first, the single-family homes and rental apartments result in
  - **$1.1 million** in tax and other revenue for local governments, and
  - **$757,000** in local government expenditures to continue providing services at current levels

- The difference between government revenue and current expenditures is defined as an "operating surplus." If it is assumed that the operating surplus is used first to service and then to pay down the debt, all debt incurred by investing in structures and equipment at the start of the first year can be entirely paid off by the end of the third year. After that, future operating surpluses will be available to finance other projects or reduce taxes. After 15 years, the 200 housing units will generate a cumulative **$19.5 million in revenue** compared to only **$15.0 million in costs**, including annual current expenses, capital investment, and interest on debt (Figure 3).



Method Used to Estimate Costs

The method for estimating local government revenue generated by home building is explained in the NAHB documents, *The Metro Area Impact of Home Building in a Typical Metro Area: Income, Jobs and Taxes Generated*. This section describes how costs are estimated.

The general approach is to assume local jurisdictions supply residents of new homes with the same services that they currently provide, on average, to occupants of existing structures. The amount that any jurisdiction spends is available from the Census of Governments, where all units of government in the U.S. report line item expenses, revenues, and intergovernmental transfers once every five years to the Governments Division of the U.S. Census Bureau. Census of Governments accounts can be aggregated for every local government in the typical metro area and then used to produce total annual expenses per single-family and multifamily housing unit (Table 1).

Not surprisingly, cost per housing unit varies substantially across the major service categories. Education accounts for the largest share of annual expenses, but the shares for police protection and miscellaneous general government functions are also substantial.

Table 1.
Total Annual Local Government Expenses per Housing Unit
(in 2008 Dollars)

	Single-Family	Multifamily
Education	$1,697	$987
Police Protection	$534	$397
Fire Protection	$245	$182
Corrections	$172	$128
Streets and Highways	$66	$46
Water Supply	$185	$97
Sewerage	$102	$53
Health Services	$226	$168
Recreation and Culture	$254	$189
Other General Government	$827	$616
Electric Utilities	$178	$133
Gas Utilities	$23	$17
Public Transit	$15	$11
Other Government Enterprises	$8	$6
Total	$4,530	$3,029

In deriving the above estimates, water supply and sewerage expenses are allocated based on gallons of water consumed per day by single-family and multifamily households. Streets and highway expenses are allocated based on average number of vehicle trips generated on weekdays. Education is allocated based on average number of children age 5 through 18. The remaining expenses listed in Table 1 are assumed to be proportional to household size and are allocated to single-family and multifamily units based on average number of persons per household.[3]

There are several factors present in most parts of the country that tend to reduce education expenses per housing unit. The first is the average number of school-aged children present in the units. According to the American Housing Survey, there is, on average, only a little over one school-aged child for every two households in the U.S. The number is about 0.6 per household for single-family and under 0.4 per household for multifamily. So education costs per housing unit are lower than costs per pupil, simply because there is less than one pupil per household.

[3] Information about vehicle trips comes from *Trip Generation*, published by the Institute of Transportation Engineers. Information about water consumption comes from *Analysis of Summer Peak Water Demands,* a study undertaken by the City of Westminster, Colorado Department of Water Resources and Aquacraft, Inc. Water Engineering and Management. Information about household size and number of children comes from the American Housing Survey, conducted by the U.S. Census Bureau for the Department of Housing and Urban Development.

Beyond that, a share of households typically send their children to private schools. According to the National Center for Education Statistics (NCES), the share is 12.6 percent of all school-aged children nationally. As public monies are very rarely used to pay for private instruction, this tends to further reduce K-12 public school expenses, although the extent to which that occurs varies from place to place. Moreover, according to the NCES another 1.7 percent of students nationwide, ages 5 to 17, with a grade equivalent of kindergarten through grade 12, are homeschooled, which further acts to reduce the cost of public education.

Finally, state governments typically pay for some public school expenses in the form of intergovernmental transfers. In the latest Census of Governments, local governments in aggregate across the country spent had about 61 percent of their current expenses on education offset by state-to-local intergovernmental transfers for education.

In addition to current expenses, providing services to residents requires that local governments make capital expenditures for items such as schools and other buildings, equipment, roads, and other structures.

Estimating capital costs is in general a more difficult and complicated problem than estimating current expenses. The approach used here is to estimate a conventional economic model, where costs are expressed as a function of labor and capital, with state level data. (Information about state and local government capital in each state can be estimated through a procedure that has been established over several decades in the technical literature on public finance; see the technical appendix for details.) The results are then applied to a local area, where information is available for every variable except capital. The local capital stock then emerges as a residual in the calculation. Consistent with the approach used to estimate current expenses, the amount of capital in each category is expressed as the amount necessary to accommodate an average single-family or average multifamily housing unit (Table 2).

Table 2.
Local Government Capital per Housing Unit
(in 2008 Dollars)

	Single-Family	Multifamily
Schools	$9,120	$5,306
Hospitals	$990	$737
Other Buildings	$2,889	$2,150
Highways and streets	$1,816	$1,258
Conservation & development	$61	$45
Sewer systems	$2,273	$1,190
Water supply	$2,990	$1,565
Other structures	$2,663	$1,982
Equipment	$232	$173
Total	$23,035	$14,405

To implement these numbers, several conservative assumptions are made to avoid understating the costs. In contrast to the way current expenses were handled, intergovernmental transfers are generally not taken into account here—it is assumed that local governments undertake all capital investment without any help from the states. The exception is highways and streets, for which the amount of current expenditures per dollar of capital is typically quite low. It is further assumed that none of this demand for capital can be met through current excess capacity. Instead, local governments invest in new structures and equipment at the start of the first year, before any homes are built. To the extent that this is not true—that, for instance, some revenue from impact or other fees is available to fund part of the capital expenditures—interest costs would be somewhat lower than reported here.

To compare the streams of costs and revenues over time, the analysis assumes that half of the current expenses and half of the ongoing, annual revenues are realized in the first year. This would be the case if construction and occupancy took place at an even rate throughout the year. Revenues in the first year also include all of the one-time construction impacts such as impact and permit fees.

The difference between revenues and current expenses in a given year is an operating surplus. At the start of the first year, capital investment is financed through debt by borrowing at the current municipal bond interest rate,[4] and the interest accrues throughout the year. Each year after that, the operating surplus is used first to pay the interest on the debt, if any exists, then to pay off the debt at the end of the year. The results are shown for the 100 single-family homes in Table 3, for the 100 rental apartments in Table 4, and for both types of construction analyzed jointly in Table 5.

The difference between revenues (the third column) and all costs, including interest on the debt, is shown in the last column. Again, the assumption that any operating surplus is being used to service the debt, and then to retire as much debt as possible at the end of the year applies. For either single-or rental apartment construction, revenue net of costs and interest is negative in the first year, but turns positive beginning in year two.

Cumulatively, revenue net of costs and interest is sufficient to pay off all debt by the end of year two for single-family construction, and by the end of year ten for rental apartments. In the combined case, where it is assumed revenue net of costs for single-family construction is available to pay down debt undertaken to provide infrastructure for rental apartments, all debt can be paid off by the end of year three. After that, revenue net of costs generated by the 100 single-family homes and 100 rental apartments is roughly $380,000 per year.

Net revenue drops somewhat below $380,000 in year eleven, due to a cost increase that occurs because capital equipment purchased at the start of the first year becomes fully depreciated and needs to be replaced at that time. All other capital investment consists of structures of various types, and these tend to have considerably longer service lives.

[4]The interest rate on municipal bonds is the monthly Bond Buyer 20-year General Obligation Municipal Bond Index available on the Federal Reserve Board's Web site: http://www.federalreserve.gov/releases/h15/data/Monthly/H15_SL_Y20.txt.

Table 3. Results for 100 Single-Family Homes

Year	Current Expenses	Revenue	Operating Surplus	Capital Investment Start of Year	Debt Outstanding End of Year	Interest on the Debt	Revenue Net of Costs and Interest
1	226,700	2,574,300	2,347,600	2,303,400	57,169	101,369	-57,169
2	453,400	743,300	289,900	0	0	2,516	287,384
3	453,400	743,300	289,900	0	0	0	289,900
4	453,400	743,300	289,900	0	0	0	289,900
5	453,400	743,300	289,900	0	0	0	289,900
6	453,400	743,300	289,900	0	0	0	289,900
7	453,400	743,300	289,900	0	0	0	289,900
8	453,400	743,300	289,900	0	0	0	289,900
9	453,400	743,300	289,900	0	0	0	289,900
10	453,400	743,300	289,900	0	0	0	289,900
11	453,400	743,300	289,900	23,200	0	0	266,700
12	453,400	743,300	289,900	0	0	0	289,900
13	453,400	743,300	289,900	0	0	0	289,900
14	453,400	743,300	289,900	0	0	0	289,900
15	453,400	743,300	289,900	0	0	0	289,900

Table 4. Results for 100 Rental Apartments

Year	Current Expenses	Revenue	Operating Surplus	Capital Investment Start of Year	Debt Outstanding End of Year	Interest on the Debt	Revenue Net of Costs and Interest
1	151,700	1,024,200	872,500	1,440,600	631,498	63,398	-631,498
2	303,400	394,800	91,400	0	567,890	27,791	63,609
3	303,400	394,800	91,400	0	501,481	24,992	66,408
4	303,400	394,800	91,400	0	432,151	22,069	69,331
5	303,400	394,800	91,400	0	359,769	19,018	72,382
6	303,400	394,800	91,400	0	284,202	15,833	75,567
7	303,400	394,800	91,400	0	205,309	12,507	78,893
8	303,400	394,800	91,400	0	122,944	9,035	82,365
9	303,400	394,800	91,400	0	36,955	5,411	85,989
10	303,400	394,800	91,400	0	0	1,626	89,774
11	303,400	394,800	91,400	17,300	0	0	74,100
12	303,400	394,800	91,400	0	0	0	91,400
13	303,400	394,800	91,400	0	0	0	91,400
14	303,400	394,800	91,400	0	0	0	91,400
15	303,400	394,800	91,400	0	0	0	91,400

Table 5. Joint Results for 100 Single-Family Homes and 100 Rental Apartments

Year	Current Expenses	Revenue	Operating Surplus	Capital Investment Start of Year	Debt Outstanding End of Year	Interest on the Debt	Revenue Net of Costs and Interest
1	378,400	3,598,500	3,220,100	3,744,000	688,667	164,767	-688,667
2	756,800	1,138,100	381,300	0	337,674	30,307	350,993
3	756,800	1,138,100	381,300	0	0	14,860	366,440
4	756,800	1,138,100	381,300	0	0	0	381,300
5	756,800	1,138,100	381,300	0	0	0	381,300
6	756,800	1,138,100	381,300	0	0	0	381,300
7	756,800	1,138,100	381,300	0	0	0	381,300
8	756,800	1,138,100	381,300	0	0	0	381,300
9	756,800	1,138,100	381,300	0	0	0	381,300
10	756,800	1,138,100	381,300	0	0	0	381,300
11	756,800	1,138,100	381,300	40,500	0	0	340,800
12	756,800	1,138,100	381,300	0	0	0	381,300
13	756,800	1,138,100	381,300	0	0	0	381,300
14	756,800	1,138,100	381,300	0	0	0	381,300
15	756,800	1,138,100	381,300	0	0	0	381,300

Comparing Costs to Revenue for Local Governments

Technical Appendix on Estimating Capital Owned and Maintained by Local Governments

Paul Emrath
NAHB Housing Policy Department

National Association of Home Builders
1201 15th Street, NW
Washington, DC 20005
202-266-8398

Technical Appendix on Estimating Local Capital Owned and Maintained by Local Governments

This appendix explains the method used to estimate the age and dollar value of local government capital by function (education, water and sewer services, etc.). The general approach is to estimate economic relationships using state-level data and then apply parameters from the state-level estimates to local data.

First, a cost share equation based on conventional production theory is described for the structures associated with each function of government. In the equations age of capital is used as a proxy for technologic change. Age of capital, in turn, is estimated as a function of population growth.

The following derivations apply to any one of the ten categories of state and local government capital—e.g., highways or school buildings—tracked in the Bureau of Economic Analysis (BEA) wealth data files. For simplicity, the notation suppresses an explicit reference to capital type. In cases where some detail of the model pertains to a particular type of capital or function of local governments, the text will make that clear.

Let y = output; L= labor, w = the price of labor, and r = the price of capital, and consider a general translog cost function:[5]

$$(1)\quad c_{it} = \beta_0 + \beta_w \ln w_{it} + \beta_r \ln r_{it} + \beta_y \ln y_{it} + \beta_a a_{it} + \tfrac{1}{2}\beta_{ww}(\ln w_{it})^2 + \beta_{wr} \ln w_{it} \ln r_{it} + \tfrac{1}{2}\beta_{rr}(\ln r_{it})^2 + \beta_{wy} \ln w_{it} \ln y_{it} + \beta_{ry} \ln r_{it} \ln y_{it} + \beta_{wa} a_{it} \ln w_{it} + \beta_{ra} a_{it} \ln r_{it} + \beta_{yy}(\ln y_{it})^2 + \beta_{ya} a_{it} \ln y_{it} + \beta_{aa} a_{it}^2$$

In the case where the firm is a government, y_{it} is essentially unmeasurable, so it seems reasonable to assume linear homogeneity in output. This simplifies the translog specification considerably:

$$(2)\quad c_{it} = \beta_0 + \beta_w \ln w_{it} + \beta_r \ln r_{it} + \ln y_{it} + \beta_a a_{it} + \tfrac{1}{2}\beta_{ww}(\ln w_{it})^2 + \beta_{wr} \ln w_{it} \ln r_{it} + \tfrac{1}{2}\beta_{rr}(\ln r_{it})^2 + \beta_{wa} a_{it} \ln w_{it} + \beta_{ra} a_{it} \ln r_{it} + \beta_{aa} a_{it}^2$$

Specification (2) still requires an estimate of $\ln y_{it}$. However, application of Shephard's Lemma generates the following two-equation system:

$$(3)\quad s_{L,\,it} = w_{it} L_{it} / c_{it} = \partial \ln c_{it} / \partial \ln w_{it} = \beta_w + \beta_{ww} \ln w_{it} + \beta_{wr} \ln r_{it} + \beta_{wa} a_{it}$$

$$(4)\quad s_{k\,it} = r_{it} k_t / c_{it} = \partial \ln c_{it} / \partial \ln r_{it} = \beta_r + \beta_{wr} \ln w_{it} + \beta_{rr} \ln r_{it} + \beta_{ra} a_{it}$$

By estimating cost shares rather than the cost function itself, the ability to estimate β_0, β_a, and β_{aa} (essentially nuisance parameters) is lost. Also lost is some precision, in the sense that a lower-order approximation is being estimated.[6] The advantage is relief from the need to supply values for the unobservable y_{it}.

[5] See, for example, Walter Diewert and Terry Wales (1987), "Flexible Functional Forms and Global Curvature Conditions," *Econometrica*, 55, 43-68.

[6] See Henri Theil, *The System-Wide Approach to Microeconomics*, University of Chicago Press, 1980, page 151.

Economic theory implies several restrictions.

Symmetry: β_{wr} is the same in both equations
Linear homogeneity in input prices: $\beta_w + \beta_r = 1$; ½ $\beta_{ww} + \beta_{wr} + ½\ \beta_{rr} = 0$; $\beta_{wa} + \beta_{ra} = 0$.

The restrictions are imposed in the usual way. One of the factor prices (w_{it}) is used as a numeraire; and only one share equation ($s_{L,\,it}$) is estimated, leaving parameters of the second, if needed, to be recovered by simple algebra. The resulting estimating equation is

$$(5) \qquad s_{L,\,it} = w_{it} L_{it} / (w_{it} L_{it} + r_{it} k_t) = \beta_w + \beta_{wr} \ln (r_{it} / w_{it}) + \beta_{wa} a_{it} + \boldsymbol{\beta}_I' \boldsymbol{I}_{it}$$

where $\boldsymbol{I}_{it}$ is a vector of indicator variables that may be added to equations for some government functions to account for outliers among specific states and time periods. More detail is provided when the regression results are discussed.

Model (5) can be estimated with any standard regression package, provided state-level annual data for L, w, and r can be specified. Series beginning in 1987 for the first two are available from the Government Division of the U.S. Census Bureau. For r, standard practice is followed by assuming cost of capital is the sum of three terms: maintenance (meaning, in this case, all non-labor operating costs), interest, and depreciation.

$$(6) \qquad r_{it} = x_{it} / k_{it} + \phi_{it} + \xi_t$$

where x_{it} is the difference between total current expenditures and labor costs, ϕ_{it} is an interest rate for appropriate types of tax-exempt public-purpose government bonds, and ξ_t is the national depreciation rate from BEA's wealth accounts.

To estimate the cost share equations, the same annual interest rate series ϕ_t is used for all states. Because the preferred series not available until 1990, two different sources are used to construct the 1987–2001 annual interest rate series ϕ_t. From 1987 through to the end of 1989, the JP Morgan Revenue Bond Index (RBI) is used. The JP Morgan RBI data are monthly. An annual interest rate is constructed by taking the average of the 12 monthly observations for each calendar year.

From 1990 to the present the Merrill Lynch 20 Year AAA GO series is used. The Merrill Lynch data are provided weekly. An annual interest rate is constructed by taking the average of the 52 observations in each calendar year.

To insure that there is no discontinuity in the series, the annual interest rate from the JP Morgan RBI index for the years 1987 1988 and 1989 is multiplied by the average of the annual ratio of the Merrill Lynch 20 Year AAA GO series divided by the JP Morgan RBI index the for the years 1990 to the present. That ratio turned out to be 0.93. The reason the ratio is less than one is largely because the Merrill Lynch index has a duration that is on average 5 years shorter than the JP Morgan RBI Index.

The final index was chosen following consultation with bonds specialists at both JP Morgan and Merrill Lynch. Although there are hundreds of thousands of unique muni-bonds, and most are rarely if ever traded, the experts felt that a 20 year maturity seemed appropriate and that the ML GO AAA series was probably best for this purpose.

In order to make the cost share equations operational, it's necessary to apportion equipment among the other nine types of capital for which it's possible to approximately match capital with expense and employment data by function of government. In general, a year-zero approach is employed, basing the analysis on the ratio of structures to equipment when both are brand new.

Suppressing the cross-sectional (state) subscript, capital k required for a specific local government function is the sum of structures k_s and equipment k_e:

(7) $$k_t = k_{st} + k_{et}$$

where $$k_{st} = k_{s0}(1-\xi_s)^{a_s}, \quad k_{et} = k_{e0}(1-\xi_e)^{a_e}$$

or, equivalently,

(8) $$k_{s0} = k_{st}(1-\xi_s)^{-a_s}, \quad k_{e0} = k_{et}(1-\xi_e)^{-a_e}$$

Brand new equipment is allocated to brand new structures based on the relative total year-zero values of structures. From this, a ratio z can be derived, which will be the same for all local government functions (or structure types):

(9) $$z = k_{e0}/k_{s0} = k_{et}(1-\xi_e)^{-a_e} k_{st}^{-1}(1-\xi_s)^{a_s}$$

The average z ratio for 50 states plus the District of Columbia in the most recent year for which we can compute it (1998) is .11642. This number is used below to help derive estimates of government-owned equipment and structures for a particular local area.

The blended ages and depreciation rates for total capital (structures and equipment) were used to compute the independent variables in the estimating equations. The nine equations (one for each function of government) were estimated, using data for the period where complete state-level government employment and finance data were available—1987 through 1998. The procedure converged quickly (in four iterations). Results are shown in Table 3.

Fit of the model was improved by including a number of indicator variables, up to three per equation. These are identified as I1, I2, and I3 in Table A1 and defined in Table A2.

Not all of the cost equations contain an indicator variable, and each indicator captures only a small number of states. Several variables simply indicate that an observation is for the state of Alaska, and it seems reasonable to suppose that the technology of providing some government services in Alaska would be different than in many other states. In the case of housing, New York appears to be an isolated outlier, and again that is not especially surprising. Other indicators capture a small number of states in New England or the Rocky Mountain area. The conservation series showed a clear break between 1991 and 1992 in Arizona. The Census Bureau instituted some procedural changes involving the collection and reporting of government finance data beginning in 1992.

Table A1. Regression Results: Cost Share Equations

	β_w	β_{wr}	β_{wa}	I1	I2	I3	Adj R^2
Residential	-0.5454	-0.1082	0.0051	0.1531	0.2150		.453
	(.0001)	(.0001)	(.0158)	(.0001)	(.0001)		
Education	-0.3801	-0.1391	0.0156				.545
	(.0001)	(.0001)	(.0001)				
Hospital	0.5682	-0.1413	-0.0247	-0.1793			.506
	(.0001)	(.0001)	(.0001)	(.0001)			
Other Buildings	0.3970	-0.1655	-0.0368				.784
	(.0001)	(.0001)	(.0001)				
Streets & Highways	-0.0345	-0.0723	-0.0110	0.2072			.598
	(.4529)	(.0001)	(.0001)	(.0001)			
Conservation	0.1846	-0.0524	-0.0017	0.3443	-0.2017	0.1210	.483
	(.0165)	(.0001)	(.6021)	(.0001)	(.0001)	(.0001)	
Sewer	-0.4148	-0.0861	0.0018				.522
	(.0001)	(.0001)	(.1985)				
Water	-0.0336	-0.1077	-0.0169				.413
	(.5780)	(.0001)	(.0001)				
Other Structures	-0.2342	-0.1112	-0.0111	0.39629			.566
	(.0021)	(.0001)	(.0004)	(.0001)			

Table A2: Indicator Variables for Cost Share Equations

Capital type	Variable	Condition for I=1
Residential	I1	state=AK
	I2	state=NY
Hospital	I1	state=AZ, NH, or VT
Streets & Highways	I1	state=AK
Conservation	I1	state=AK
	I2	state =NY or CT; or state=AZ and year < 1992
	I3	state=ID, MT, ND, or WY
Other Structures	I1	state= NE, NY, or WA

In the equations above, age of the capital stock appears as an explanatory variable. This is not readily available, even at the state level. A commonly used approach employs perpetual accounting, investment, and depreciation rates to base-year estimates.[7] The procedure used here begins with that approach, but then relates the investment rates to population growth rates, one of the few items for which consistent time series are available for individual U.S. counties.

From BEA national wealth data, the following are available or can easily be computed:

ξ = real annual rate of depreciation (defined broadly, as BEA does, to include a normal rate of obsolescence and retirement of assets)
$>$ = monthly depreciation rate, a simple algebraic transformation of ξ.
N_t = real, net (of depreciation) rate of investment in year t, t=1946,…,2000.

[7] As in Douglas Holtz-Eakin, "State-Specific Estimates of State and Local Government Capital," *Regional Science and Urban Economics*, Vol. 23, No. 2, April 1993, pp. 185-210.

From data compiled by the Governments Division of the Census Bureau, and ratios employed by BEA to analyze this data, the following can be computed for state i and t=1977,…,1999:

vn_{it} = real investment in new assets state i in year t.
ve_{it} = real investment in existing assets state i in year t.
v_{it} = real investment in state i in year $t = vn_{it} + ve_{it}$.
x_{it} = current expenditures associated with the relevant type of capital state i in year t.

From standard Census Bureau data it is possible to compute
Π_{it} = population growth in the state relative to the national rate; i.e.,

$$\Pi_{it} = \frac{\Delta\rho_{it}}{\rho_{it-1}}\left[\frac{\sum_i \Delta\rho_{it}}{\sum_i \rho_{it-1}}\right]^{-1}$$

The starting point consists of initial end-of-year estimates of the real capital stock, k^0_{i76}, determined by allocating capital to each state according to its share of current expenditure, x_{i77}. This procedure, the one employed for example by Holtz-Eakin (1993), is used here only for the purpose of supplying initial values to be modified in subsequent iterations.

Perpetual inventory accounting can be used to calculate the following recursively for t=1977,…,1999:

(10) $$k^0_{i\,t+1} = k^0_{it}(1-\xi) + v_{it+1}(1->)^6$$

This assumes that investment made during period t+1 depreciates an average of 6 months by the end of the period. Then relative (to the national rate) net real rates of investment can also be computed:

(11) $$\equiv^0_{i\,t} = \left[\frac{v_{it} - \delta\, k^0_{it-1}}{k^0_{it-1}}\right] N_t^{-1}$$

The goal is to obtain estimates of parameters $\forall_j$ and 2_q in the following regression relationship:

(12) $$\equiv^0_{i\,t} = \sum_{j=1}^{J} \alpha^0_j \rho^0_{it-j} + \sum_{q=1}^{Q} \vartheta_q D_q$$

where J is the longest lag considered and the D_q are indicator (dummy) variables. The hypothesis underlying this specification is that a state's rate of investment (relative to the national rate) is a function of past rates of its population growth (also relative to the national rate), with indicator variables to account for anomalies in some states due to peculiarities that are difficult to observe and quantify. Inspection of the pair wise correlations between $\equiv_{i\,t}$ and Π_{it-j} reveal that they begin to decline at or before the lag reaches eight years, depending on the type of capital. Thus, model specification for each type of capital began by tentatively considering population growth effects up to J=8. The final specification varies from case to case.

As a practical matter, the final specifications employ averages of population growth rates lagged over several years. Over the course of several experiments, the sum of the coefficients on the population variables never changed substantially when an average was substituted for a series of individual lags. Coefficients on individual lags tended to fluctuate widely and lack statistical significance, due to collinearity. The use of averages thus aids interpretation without impacting the marginal impacts predicted by the equations in a meaningful way.

Three indicator variables were used in all but the hospital capital equation, which employed four. In most cases, indicator variables flag relatively few states (Table A3).

Table A3: Indicator Variables for Relative Investment Rate Equations

Capital Category	DVERYHI=1	DHIGH=1	DLOW=1	DVERYLOW=1
1 Equipment	DC, WY	AZ, CO, MT, UT	AR, NH, RI	
2 Residential Buildings	DC, HI, MA, NY	CT, DE, RI	CO, FL, ID, NM, TX, UT, VT, WY	
3 Educational Buildings	WY	HI, NM, TX	CA, VT, WI	
4 Hospital Buildings	WY	AL, FL, GA, HI, IA, ID, KS, NY, OH, WA	AR, CT, DE, IL, KY, ME, OR, UT, WI, WV	AZ, VT
5 Other Buildings	DC, WY	HI, MD	AR	
6 Highways and Streets	WY	DC, IA, MN, MT, ND, NE	AR, ME, NH, SC, VT	
7 Conservation & Development	HI, WY	AZ, LA, MT	AL, NY, OK, TN, VA	
8 Sewer Systems & Structures	DC, NY, WA	MA, MD, NJ, OH, RI, WI	AR, NC	
9 Water Supply Facilities	CO, DC, SD, WY	FL, NV	DE, NH	
10 Other Structures	DC	NE	NH	

Given initial estimates, it's possible to begin the perpetual inventory accounting process at an earlier date. If we assume that the World War II period was atypical and restrict ourselves to post-war population data, an 8-year lag in (12) implies that 1954 is the first year for which we can obtain state investment estimates. Hence, state capital stocks in 1953 are estimated by allocating the national capital stock in that year according to its share of the U.S. population, then estimating state investment in the years from 1954 through 1976 recursively according to

$$(13) \qquad v^0_{it} = k^0_{it-1} (\xi + N_t \equiv^0_{it})$$

where $\equiv^0_{it}$ is estimated from (12). In words, (13) says that investment is enough to cover depreciation, plus another term which is the net national rate of investment multiplied by a relative factor specific to state i. It is then possible to combine (13) with (10) to derive estimates of the capital stock for the years 1954 through 1976 in most states. (A lack of complete data for in earlier years pushes the first estimate for Alaska forward to 1962.)

In this way revised estimates k^1_{i76} are derived, and these can be used to restart the process by repeating steps (10) through (13). This results in successively revised estimates k^1_{it} and $\equiv^1_{it}$ for t=1977,…,1999; parameters $\forall^1_j$ and 2^1_q; ν^1_{it} for t=54,…,76; and k^2_{i76}. This ends the first iteration.

This process can be repeated until either a convergence criterion is satisfied. The particular criterion used was an average absolute percentage change in the k_{i76} no greater than 10^{-10} between iterations.

The procedure was carried out for all 10 BEA categories of state and local government capital. Each of the ten equations converged in fewer than 10 iterations. The final estimates are shown in Table A4.

Table A4. Final Regression Results: Dependent Variable=Relative Investment Rate

	Equipment	Residential	Education	Hospital	Buildings nec
Iterations to Convergence	8	6	6	6	6
Final Regression Coefficients (p-values):					
Constant	-0.2590	0.5460	-0.0227	0.3663	0.5439
	(.0003)	(.0001)	(.8295)	(.0001)	(.0001)
Lagged relative population growth rates:					
Population lag 1	0.4337		0.3852		0.1336
	(.0001)		(.0001)		(.0001)
Population lag 2-5	0.1707	0.0662			
	0.0212	(.1225)			
Population lag 2-8			0.6865		0.0961
			(.0001)		(.0002)
Population lag 6-8		0.0805		0.1270	
		(.0532)		(.0009)	
State indicator variables:					
DVeryhi	5.6639	2.9842	7.2485	4.1282	1.7082
	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)
DHigh	1.2733	0.7862	1.6538	1.4240	1.3839
	(.0002)	(.0001)	(.0001)	(.0001)	(.0001)
DLow	-1.3392	-0.8119	-1.2254	-0.8407	-0.6383
	(.0001)	(.0001)	(.0003)	(.0001)	(.0001)
DVerylow				-1.7778	
				(.0001)	
Adjusted R^2	.432	.426	.311	.323	.402

Table A4. Continued

	Streets	C&D	Sewer	Water	Other
Iterations to Convergence	6	6	6	6	8
Final Regression Coefficients (p-values):					
Constant	0.8370	0.0938	0.4386	0.2036	0.2754
	(.0001)	(.0617)	(.0001)	(.0001)	(.0016)
Lagged relative population growth rates:					
Population lag 1				0.1967	0.2253
				(.0001)	(.0030)
Population lag 2		0.0950			
		(.0371)			
Population lag 2-5	0.2462				
	(.0001)				
Population lag 5			0.0516		
			(.1461)		
Population lag 2-8				0.4270	0.5368
				(.0001)	(.0001)
Population lag 3-8		0.2653			
		(.0001)			
Population lag 6-8	0.0770		0.0701		
	(.0318)		(.0594)		
State indicator variables:					
DVeryhi	4.955	2.387	1.348	2.270	13.405
	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)
DHigh	1.340	1.223	1.025	0.396	5.981
	(.0001)	(.0001)	(.0001)	(.0206)	(.0001)
DLow	-0.684	-0.785	-0.745	-0.126	-2.172
	(.0006)	(.0001)	(.0001)	(.0001)	(.0001)
Adjusted R^2	.502	.338	.268	.496	.528

The estimated pre-1977 investment series can be spliced onto the 1977-1999 data and the results used to estimate the average age of capital, by type, in each state. The procedure is as follows. First, set the average age of capital in state equal to the national average for 1953. Then, use perpetual accounting to recursively calculate the average age in subsequent years:

(14) $$a_{i\,t+1} = [(a_{i\,t}+1)\ k_{it}(1-\xi) + \tfrac{1}{2} vn_{it+1}(1->)^6 + ap_t\ ve_{it+1}(1->)^6]/k^0_{i\,t+1}$$

where ap_t is the average age of the relevant type of private capital, in accord with the method used by BEA which assumes that existing assets purchased by governments are "typical".

The process of deriving estimating capital stock estimates for a particular local area begins by adapting the average age equation (14) to location m:

$$a_{mt} = [(a_{mt-1}+1)\ k_{mt-1}(1-\xi) + g_t\ v_{mt}(1->)^6]/[k_{mt-1}(1-\xi) + v_{mt}(1->)^6]$$

where $g_t = \dfrac{.5\sum_i vn_{it} + pa\sum_i ve_{it}}{\sum_i v_{it}}$, that is, the average end-of-the year age of total assets (including both new and used) purchased by all states in the country during the period.

Then (13) is substituted into the average age formula and the capital factor is eliminated in order to obtain

$$(15) \qquad a_{mt} = \frac{(a_{mt-1}+1)(1-\delta)+g_t(\delta+N_t\eta_{mt})(1-\varepsilon)^6}{1-\delta+(\delta+N_t\eta_{mt})(1-\varepsilon)^6}$$

Equation (13) can be used to estimate $\equiv_{mt}$ from local relative population growth factors Π_{mt}. Starting with the national average age for 1954 as initial estimate of the average age of the capital stock in m, (15) can be applied to calculate a_{mt} recursively for subsequent years.

The result is a recipe for estimating the age of the capital stock for a particular local area. To be implemented, the recipe requires only data on local population growth.

Given the age estimate—along with estimates of the parameters β_w, β_{wr}, and β_{wa} from the cost share equations, capital depreciation rates ξ_t from BEA, a current rate on tax-exempt bonds ϕ_{mt} , and values for w_{mt}, L_{mt}, and x_{mt} that can be obtained for any unit of government from data bases maintained by the U.S. Census Bureau—capital k_{mt} is the only unknown in the local cost share equation

$$(16) \quad [w_{mt} L_{mt} + x_{mt} + (\phi_{mt}+\xi_t)\, k_{mt}]\cdot[\beta_w + \beta_{wr} \ln((x_{mt}/k_{mt} + \phi_{mt}+\xi_t)/w_{mt}) + \beta_{wa}\, a_{mt} + \boldsymbol{\beta}_I'\boldsymbol{I}_{mt}] = w_{mt} L_{mt}$$

However, it's necessary to account for the fact that capital in (16) consists of both structures and equipment. Equations (7), (8), and (9) imply that

$$(17) \qquad k_{mt,s} = \gamma_{mt} k_{mt} \quad \text{and} \quad k_{mt,e} = (1-\gamma_{mt})\, k_{mt} \quad \text{where}$$

$$(18) \qquad \gamma_{mt} = [1 + z(1-\xi_e)^{a_{mt,e}}(1-\xi_s)^{-a_{mt,s}}]^{-1}$$

By using the 1998 state average value (.11642) for z, it's possible to compute γ_{mt} from BEA's depreciation rates and the estimated ages of structures and equipment. In turn, γ_{mt} can be used to compute

$$(19) \qquad a_{mt} = a_{mt,s}\, k_{mt,s} / k_{mt} + a_{mt,e}\, k_{mt,e} / k_{mt} = \gamma_{mt}\, a_{mt,s} + (1-\gamma_{mt})\, a_{mt,e}$$

and

$$(20) \qquad \xi_{mt} = \gamma_{mt}\, \xi_{t,s} + (1-\gamma_{mt})\, \xi_{t,e}$$

for the blended age and depreciation rate of capital, respectively. Substitution into (16) yields a formula that can be applied in practice:

$$(21) \quad [w_{mt} L_{mt} + x_{mt} + (\phi_{mt} + \gamma_{mt}\xi_{t,s} + (1-\gamma_{mt})\, \xi_{t,e})\, k_{mt}]\cdot[\beta_w + \beta_{wr} \ln((x_{mt}/k_{mt} + \phi_{mt} + \gamma_{mt}\xi_{t,s} + (1-\gamma_{mt})\, \xi_{t,e})/w_{mt})] + \beta_{wa}(\gamma_{mt}\, a_{mt,s} + (1-\gamma_{mt})\, a_{mt,e}) + \boldsymbol{\beta}_I'\boldsymbol{I}_{mt}] = w_{mt} L_{mt}$$

This is the formula used to estimate k_{mt}, the dollar value of a particular type of government capital in a particular local area. Because capital appears twice in the nonlinear expression, a closed form solution for it does not exist. Finding the solution is a one-dimensional problem, however, so k_{mt} can be recovered through elementary numerical methods.