JOURNAL OF REGIONAL SCIENCE, VOL. 47, NO. 5, 2007, pp. 935–963

THE IMPACT OF SPECIFIC-SECTOR CHANGES IN EMPLOYMENT ON ECONOMIC GROWTH, LABOR MARKET PERFORMANCE AND MIGRATION

Harvey Cutler

Department of Economics, Colorado State University, Fort Collins, Colorado 80523. E-mail: Harvey.Cutler@colostate.edu

Stephen Davies

Department of Agricultural and Resource Economics, Colorado State University, Fort Collins, Colorado 80523. E-mail: Stephen.Davies@colostate.edu

ABSTRACT. It is common in empirical regional economics to use total employment as an explanatory variable while investigating issues such as the level and distribution of income and migration. This paper argues that sector-specific changes in employment and labor market performance can have different effects on economic growth, the collection of tax revenue, migration, and the level and distribution of household income. As such, it is important to model sectors separately. We find that expansions in employment opportunities for a high-wage sector such as computer manufacturing or bioengineering, a medium-wage sector manufacturing, and the lower-wage sector of retailing have differing economic consequences for a small city. We use a data intensive computable general equilibrium model to obtain these results.

1. INTRODUCTION

It is common in the empirical regional economics literature to use total employment as an explanatory variable when examining issues related to migration and income distribution. Greenwood and Hunt (1984), Blanchard and Katz (1992) and Bartik (1993) examined the responses of household migration to changes in total employment across regions. Bartik (1994) and Levernier, Partridge, and Rickman (1998) also used total employment to examine the impact on the distribution of family income. This paper argues that sector-specific changes in employment and labor market performance can have different effects on economic growth, migration, and the level and distribution of household income. As such, it is important to model sectors separately. As an example,

*The authors thank the three referees who all made excellent comments and improved the paper substantially. We would also like to thank the editors of this journal who also contributed significantly to the evolution of this paper. Any remaining errors are the responsibility of the authors.

Received: March 2005; revised: March 2006, May 2007; accepted: June 2007.

Blackwell Publishing, Inc., 350 Main Street, Malden, MA 02148, USA and 9600 Garsington Road, Oxford, OX4 2DQ, UK.

we find that an expansion in employment opportunities in a high-wage sector, such as computer manufacturing, bioengineering or engineering consulting, increases income inequality, while expansion of a medium-wage sector, manufacturing, and a lower-wage sector, retailing, tends to reduce income inequality. The impact on local tax revenue also varies considerably across sectors. This analysis is done with the use of a data intensive computable general equilibrium (CGE) model for the City of Fort Collins, Colorado, which allows for much greater detail in the specification of a regional economy than standard econometric techniques usually offer.

Bartik (1994) points out that total employment is an endogenous variable, so that changes could be due to either new firms entering the region or exogenous changes in population. All of the above authors attempt to use instruments to correct the problem but it is difficult to assess their degree of success. Using a CGE model, it is possible to directly increase the demand for workers in various productive sectors, so no confusion exists as to the source of economic growth. In addition, we also examine the impact of exogenous increases in population, which contributes to the literature on employment versus population-led growth. The literature commonly asks whether it is employment or population that leads economic growth.[1] Instead, we are interested in the economic consequences of both employment- or population-led growth on overall labor market performance, the distribution of income, general economic activity, and city tax revenue.

The sectors to be examined are retailing, manufacturing and a high-wage industry, such as computer manufacturing or bioengineering. The study was originally motivated by the City of Fort Collins' interest in examining the economic impact of constructing a large new retail center (Lifestyle Retail Center) that would employ 1,000 workers. However, the city was also considering using the same land for medium-wage manufacturing, which would also employ approximately 1,000 workers. A third option, seen as ideal by many, would be to expand the high-wage industry by attracting a combination of computer manufacturing, software design, bioengineering, natural resources consulting, and other engineering services jobs that would use the land. The outlook for growth in retailing, medium-wage manufacturing, and the high-wage industries has varied significantly across the past decade. Therefore, we elected to make comparisons using a similar employment increase for all three sectors rather than to try to make subtle adjustments to account for differences in expectations of sector-specific growth.[2] For comparison, we also consider the economic consequences of population-led growth.

[1]Depending upon the region examined, researchers have found causality running in both directions. As examples, see Greenwood and Hunt (1984), Mathur and Song (2000), Freeman (2001), and Partridge and Rickman (2003).

[2]Our reviewers expressed concern about the likelihood of computer manufacturing being a source of further growth in the city. We are sympathetic with this concern, but the base data was collected in 1996 when the computer manufacturing industry was thriving. We feel that there are alternative industries related to technology, software design, bioengineering and natural resource

These three industries represent a good profile of industries for which Fort Collins has a significant comparative advantage. Location quotients based on employment for manufacturing, high-wage industries and retailing are 0.73, 3.9, and 1.4, respectively. These values show that, for example, retailing employment as a percent of total employment in Fort Collins is 1.4 times that ratio for the nation on average. The high-wage and retail sectors indicate a relative specialization compared to national averages and a willingness of firms in these sectors to move into the city. Government and university employment easily exceed national averages as well, so the low location quotient for manufacturing may be a simple factor that if some sectors take on major proportions, then something has to receive a lower percentage. However, the city has constantly entertained requests for manufacturing firms to move into the city. Besides being at the foothills of the Rocky Mountains, Fort Collins has a rich labor pool. The combination of Colorado State University, the U.S. Department of Agriculture, the U.S. Geological Service, and Hewlett-Packard has resulted in a range of labor skills that are advanced and quite varied. This is supported by the fact that upper income households, with incomes above $50,000 per year, make up for 48 percent of households in Fort Collins, while the national average is 32 percent.

In the context of the employment-led growth simulations, the role of household migration is a central determinant of outcomes in this analysis. Greenwood and Hunt (1984) analyzed 57 labor markets in a five-equation system and concluded that migrating workers fill between 20 and 80 percent of every new job created, while Bartik (1993) concluded that on average, migrating workers fill 75 percent of new jobs in a city. We experiment with the varying migration elasticities implied by Greenwood and Hunt and find that different migration patterns lead to dissimilar outcomes with respect to the level and distribution of household income and local tax revenue.

Porter (2003) demonstrates that regional economies differ substantially with respect to the level of wages, wage growth, employment growth, and the number of patents, which acts as a proxy for human capital. Schwarm and Cutler (2003, 2005) also examine aggregation issues and find that towns and small cities in the same region respond differently to identical economic shocks. This variation is due to differential impacts on relative wages across municipalities. Local policy makers therefore need access to the disaggregated analysis similar to that done in this paper to make informed decisions about types of economic growth to encourage. An important focus of our analysis is computing changes in real household income as a result of growth in specific sectors for the *original* residents in six household groups. Since original residents vote on policy change, the varying effects on this group from different types of growth is important to understand.

consulting that have the potential to provide high-wage jobs and replace computer manufacturing. While intermediate demand may vary among these industries, the critical role of workers per household as it affects labor supply and expenditure patterns would be unchanged.

Section 2 presents a description of the CGE model used and the data collected. Section 3 presents the simulation results and Section 4 is the conclusion.

2. THE CGE MODEL AND DATA

CGE Model

A CGE model captures the economic interaction between households, the private sector, the *local* government and the regional economy. Our model is based closely on Berck, Golan, and Smith's (1996) *Dynamic Revenue Analysis Model* (DRAM) developed to aid policy analysis in California. We have completely changed the base data to reflect the City of Fort Collins, and have added selected equations to make the model more consistent with a smaller region. Nonetheless, the structure is substantially the same as their model.

Households represent all families who live in the city, in either single residential homes or multiple unit dwellings. Equations (1)–(5) in the appendix describe the behavior of the six household groups, which differ by income level, as shown in Table 1. Equation (2) shows that household income comes from labor (Y_L), land (Y_{LA}), and capital income (Y_K). Labor income is derived from earnings within the city and wages of workers who commute out of the city (CMO_L). Local earnings are obtained by netting out earnings by commuters into the city through the expression $CMI_L{*}CMIWAGE_L$. Disposable income is calculated by adding retirement flows and remittances to labor income and subtracting taxes, as in equation (3).[3] Consumption demand is derived in equation (4) from a Cobb-Douglas utility function, which is affected by real disposable income (YD_H) and price movements relative to a base price ($P_I/P0_I$). Two other equations solve for household savings, S_H (equation (5)), and the overall price level faced by each household group, CPI_H (equation (1)).

Producer Behavior and Factor Supply

Table 1 shows that firms are grouped into 17 productive sectors, which demand inputs from three labor groups (FD_L), capital (FD_K), and land (FD_{LA}). The three labor groups are differentiated by wage rates (RA_L). Equations (6)–(12) describe the output of producers (DS_I), and their demand for factors, while equations (21)–(26) show how factor supplies are modeled. Equations (7) and (8) present a Cobb-Douglas production function and the associated first-order conditions. These equations guarantee that the private sector will maximize profits by choosing optimal levels of all factors, subject to standard production function relationships. Table 1 presents the specific groupings of these factors. Also,

[3]There are many tax rates on labor, capital, sales taxes, use taxes, etc. in the model. These rates start with the letters TAU and are indexed over different subsets of sectors or factors. The appendix contains descriptions of all tax rates. In the descriptions of the equations, we have suppressed discussions of these parameters because the role of taxes is straightforward.

TABLE 1: Structure of the Model

Profit Maximizing Sectors		
1) Agriculture services	10) Transportation and utilities	
2) Agricultural production	11) Lodging	
3) Agricultural processing	12) Wholesale	
4) Low services—hair, cleaners, etc.	13) Retail	
5) High services—legal, medical	14) Finance, insurance and real estate (FIRE)	
6) Construction	15) Restaurants	
7) Manufacturing	16) Universities and JCs	
8) Mining	17) School District	
9) Computer Manufacturing		
Housing Market	**Local Government**	
HS1 < \$120,000	1) Services: Police, Fire, Transportation, Library, Parks and Recreation, and Administration	
\$120,000 < HS2 < \$200,000		
\$200,000 < HS3		
HS4-multiple units	2) Taxes: Sales, Use, Property and Other	
Household Groups:		
HH1 ≤ \$10,000		
\$10,001 ≤ HH2 ≤ \$20,000		
\$20,000 < HH3 ≤ \$40,000		
\$40,000 < HH4 ≤ \$50,000		
\$50,000 < HH5 ≤ \$70,000		
\$70,000 < HH6		
Factors of Production:		
Labor Groups	**Capital Stock**	**Land**
\$20,000 ≥ L_1	K—buildings and factories used by the productive, residential and public use	Land—land used by the productive, residential, and public use (acres)
\$20,000 < L_2 ≤ \$50,000		
\$50,000 < L_3		

the producing sectors demand intermediate inputs in fixed proportions ($AD_{I,J}$), as shown in equation (9). Equations (10)–(12) simply calculate the income received by each factor as a function of its quantity demanded and factor price.

The local supply of labor comes directly from the six household groups described earlier, from commuters into the city, and from household migration. Total households, calculated in equation (25), are determined by the base number of households in the city ($HH0_H$) times the natural rate of population growth ($NRPG_H$) and as a function of real household income (YD_H/CPI_H). Moreover, total households are inversely related to the relative size of nonworking to total households in the economy (HN_H/HH_H). In essence, the differences between the solution for households in a simulation and the base level reflect net migration and population growth for the city. The parameters ETAYD and ETAU are elasticities. In equation (21), the proportion of local households who are working (HW_H/HH_H) is determined as a function of real wages internal to the city (RA_L/CPI_H), and how they compare to external wages (EXWGE2). Commuting out and in are described in equations (22) and (23), respectively. Commuting out is a function of CMO0, the base number of workers commuting out, and EXWGE1, the external wage rate. The parameter $ECOMO_L$ is an elasticity describing the responsiveness of commuters to wages inside versus outside the city. The behavior of commuters into the city is modeled in a similar way in equation (23). Equation (26) calculates the number of nonworking households as the difference between total households and working households.

The supplies of land and capital are treated differently. Equation (24) specifies land supply as a function of LAS0, the base land area in the city and the returns to land relative to its base value ($R_{LA,I}/R0_{LA,I}$). The ratio of domestic supply relative to its base ($DS_I/DS0_I$) is also a factor. The parameter ETAL is the elasticity describing the responsiveness of land supply to rates of return on land and domestic output. In a similar fashion, in equation (20), the total capital stock ($KS_{K,IG}$), is a function of the base stock less depreciation plus the new capital supply ($N_{K,I}$).

Equation (18) describes the new capital supply, which is also net investment by firms, as a function of $N0_{K,I}$, the base value of investment, and relative returns to capital ($R_{K,I}/R0_{K,I}$). As with the land supply equation, the ratio of domestic output relative to its base is a factor. The elasticity of net investment is described by ETAIX. The variable CN_I is the resulting investment demand by sector, which is determined in equation (19) as a function of new capital supply.

Trade Relations

Regional economies are usually small, open economies that face considerable competition from imports and opportunities to export. Moreover, relative changes in external and internal prices can have a large effect on simulation outcomes. Equation (13) describes exports (CX_I) as a function its base value ($CX0_I$) and the local domestic price (PD_I) of a product relative to its world export price ($PW0_I$). The elasticity of export demand is described by $ETAE_I$. Imports are described through the two equations (14) and (15). Equation (14) calculates the proportion of domestic demand that is supplied locally (D_I), which, similarly to the export equation, is described by a base value, relative domestic prices compared to import prices, and an elasticity that describes its responsiveness ($ETAD_I$). Imports are calculated in equation (15) as the portion of domestic demand (DD_I) that is not supplied locally.

Two additional equations complete the trade sector. In equation (16), the price of goods in the domestic market is calculated as a weighted average of the domestic producer price and the world price of imports. This provides the average price seen by purchasers of a product in the local economy. Finally, the financial side of the trade balance is calculated in equation (17). Since Fort Collins is a small, open economy, savings can easily flow out of or into the city to help finance new investment or net exports. Clearly, it is not accurate to constrain investment by local savings, given that the economy draws resources from many different parts of the country via branch banking. Net foreign savings is therefore available, as an unconstrained variable, to balance the difference between returns to foreign ownership of labor and capital (LNFOR and KPFOR), net exports, remittances ($PRIVRET_H$), government transfers ($GVFOR_G$) and net wages from commuters.

Local Government

Local government revenue is described in equation (27), which shows it to be a function of a wide range of taxes related to local production, exports, imports, factor payments and household income. Equations (28) and (29) describe the city's demand for intermediate inputs and factors, respectively. The variable $CG_{I,GN}$ in equation (28) is local real government consumption of inputs required in the course of its provision of services, while AG allocates tax revenue (Y_{GN}) and government transfers ($GVFOR_{GN}$) into expenditures according to the fixed proportions found in $AG_{I,GN}$. Equation (29) describes the city's demand for factors ($FD_{F,GN}$) and is structured similarly to the government consumption equation.

Model Closure Equations

Each factor and product market has a set of closure equations which provide insights into the equilibrium behavior of the model. Equation (30) closes the labor market by setting total supply of labor equal to total demand for that factor. Supply consists of laborers coming from resident working households plus workers commuting into the city. The parameter $JOBCOR_{H,L}$ transforms working households into workers. This is set equal to the sum of local factor demand and workers commuting out of the city. There is one equation for each labor category, which determines the wage rate for that labor group. Capital and land have equations specified for each product and factor. So, in equation (31), capital stock must equal the factor demand for capital in each of the 17 productive sectors. Thus, separate returns to capital, by sector, are created through these closure equations. The land closure equation in equation (32) works the same way. Equation (33) is an identity that ties all sources and uses of a sector's production together. Total local demand for each product (DD_I) is calculated in equation (34).

To summarize the model, consider an expansion in the manufacturing sector by raising the base value of exports (CXO_I) in equation (13) to represent an increase in export sales. Demand curves for labor shift out in manufacturing (via equation (8)). Increased labor is required, and comes from the natural rate of population growth, from nonworking households entering the workforce, a change in commuting patterns and increases in population by in-migration of new households. These effects are shown in equations (21)–(23), and (25), respectively. Changes in wages across the three labor groups can be uneven. Indirect multipliers lead to growth in local sectors, such as construction, low and high services, and restaurants. Moreover, the CGE model calculates the changes in prices faced by each household group and the city's CPI. Local tax revenue will rise, and tax revenue per acre and per new household can be estimated to determine whether the quality of city services will rise or not.

Data

As the data used in this paper are fairly extensive, we elected only to discuss the sources of employment, wages, land, capital, and various local taxes. A more complete description of the data set is presented in Schwarm and Cutler (2003).

The Colorado Department of Labor collects data on the number of workers in each sector, as well as wages paid to those workers. This data set is collected from two different sources, ES-202 and unemployment insurance (UI). ES-202 data summarizes quarterly reports by firms concerning the number of workers employed and the total wage bill. Theoretically, every private employer is required to supply this information and the data are collected on a city-by-city basis. In addition, every worker in the private sector has an unemployment insurance number, which allows the state to track wages earned by individual workers for every quarter, and the workers can be mapped back to individual firms. Some employers are not covered by the ES-202 and UI programs, such as school districts and local, state, and federal governments. These entities were contacted separately to obtain their wage and employment data. In addition, single proprietors must also be accounted for and added to the data set.

By merging these sources, a distribution of employment and wages by sector (Table 1) was developed, which could then be used to evaluate a wide range of policy scenarios. For the purposes of our analysis, we divided workers into the three groups (L_1, L_2 and L_3) presented in Table 1, and all sectors employ different percentages of these three types. The distributions for high-wage industries, manufacturing and retailing play an important role in the analysis of this paper.

The county assessor's office keeps records on the use of each parcel of land in the county because property taxes differ across commercial and residential properties. Abstract codes identify commercial parcels for most producing sectors and residential housing categories shown in Table 1. Included in each parcel are data on the acreage of the parcel and market values for land and structures (capital). The county assessor's office thus provides excellent data on land and capital.

The data collected from the City of Fort Collins consists of employment and wages, nonlabor expenditures for city services, and the taxes collected by the local government. We divided the city's expenditures into five categories: the police, fire, and transportation departments; city administration; and library, parks, and recreation.

3. SIMULATIONS

The objective of this section is to present and compare simulation results for separate expansions in high-wage industries, manufacturing, retailing, and also for exogenous population growth. We examine the impact on general economic growth, including tax revenue and several measures assessing the use of land, labor market outcomes, and the level and distribution of household income. We first describe the methods used to set up the simulations and choose key parameters of the model. We then present several relevant characteristics of the economy and, lastly, present the results of the simulations.

Setting up the Simulations

Since manufacturing and high-wage sectors are export driven, with over 90 percent of their output sold externally, we raised the export demand in these two cases by increasing $CX0_{I}$, the base export quantity, separately for each sector (See equation (13)). The retail sector depends importantly on both the export and local markets. The City of Fort Collins has estimated that approximately 65 percent of retail output is sold locally, while the remainder is exported. To capture the local effect, we increased the base capital stock in retailing ($KS0_{K,IG}$ in equation (20)), which creates an exogenous increase in capacity and, therefore, the supply of retail goods. This addition causes a fall in retail prices and a subsequent increase in quantity demanded for retail. To keep the base proportions of local to export sales, we increased the external demand for exports in retail. For all three simulations, the initial direct increase in employment is 1,000 workers per sector for reasons discussed in the introduction.

We also elected to simulate an exogenous population increase for several reasons. The literature typically asks whether it is employment or population that leads economic growth, but does not consider the economic implications of different sources of growth. In addition, the City of Fort Collins has sufficient amenities to attract new residents before they secure employment, so it is of interest to understand the economic impact of in-migration from a policy

TABLE 2: Characteristics of Private Sectors and Households

Sector Characteristics			
	Manufacturing	Computer Manufacturing	Retail
Employment	6,007	3,784	4,208
(Percent of Total)	(9.3%)	(5.9%)	(6.6%)
Average Wages	$24,888	$60,500	$10,178
Intermediate Demand (mil of $)	804.4	847.4	50.4

Household Characteristics		
	Number	Workers per Household
HH1 < 10,000	3,491	1.1
HH2:$10,000–19,999	5,197	1.8
HH3:$20,000–39,999	8,972	1.4
HH4:$40,000–49,999	2,981	1.7
HH5:$50,000–69,999	8,595	1.9
HH6 ≥ $70,000	10,883	2.1
Total	*40,119*	

perspective.[4] For the population simulation, we increased the natural rate of population growth, so that households increase by 700, which is the mid-point increase in households for the three employment-led simulations.

The simulations should be seen from a medium-run perspective, which is the point at which all direct and indirect multiplier effects have occurred. The indirect effects represent households migrating into the city to satisfy the initial sector expansion, as well as growth in services, restaurants, construction, etc. There will also be changes in commuting patterns in and out of the city to support city growth. We hypothesize that this effect could take up to four years to occur.

Table 2 presents selected characteristics of the three sectors of interest and the six household groups. The average annual wage for manufacturing, the high-wage sector and retailing vary considerably and play important roles in the multiplier effects. The bottom half of Table 2 shows the number of households in the six household groups, which are differentiated by income levels. As shown in equation (3), household income consists of labor, land, and capital income. The wealthiest household is HH6, with $70,000 and above in annual income accounts for approximately 25 percent of total households in the city. The last data column presents the number of workers per household for each

[4]Fort Collins, CO is typically rated as one of the top small cities in the country, in which to reside. The *Men's Journal,* April 2005 rated Fort Collins as the best city to live in the U.S., Employment Review, June 2002 rated Fort Collins the 17th Best Place to Live and Work in America and AARP Magazine, May & June 2003 rated Fort Collins as the #1 Best Place to Reinvent Your Life. As such, Fort Collins has consistently seen new households locating in the city before they find employment.

household group. HH6 averages 2.1 workers per household while HH1 averages 1.1 workers per household. The 2.1 workers for HH6 reflect teenagers who work, as well as additional family members in the household beyond a wife and husband. The number of workers per household plays an important role in the interpretation of the simulations below.[5]

Determining Key Parameters in the CGE Model

As with any CGE model, we make assumptions about functional form, parameter values, and organization of the base data that could influence results. The first assumption related to functional form is about whether to use a Cobb-Douglas or CES production function. We have performed multiple simulations using both specifications and found that results of the model do not change significantly. On average, the CES specification results in slightly larger economic impacts for a given simulation, but the important results regarding sector-specific impacts and the effect on household income do not change. Therefore, we report results using the Cobb-Douglas production function found in equations (7) and (8). For consumption, we also use a Cobb-Douglas utility function to describe the behavior of consumers, with associated first-order conditions that are a function of real household income and relative prices. We considered a linear expenditure configuration as well, but, once again, results do not change in any significant manner.

Berck et al. (1996) provide an in depth literature survey to determine appropriate elasticities of labor supply for household groups differentiated by income. Their analysis indicates that elasticities for low-income households are 0.1 and range upward to 0.8 for upper-income households (>$70,000). We used these estimates for our base level results. However, we experimented with large elasticities, up to 2.0, which were found by Berck et al to be consistent with estimates for women. For the employment-led simulations, more nonworking households sought employment with the higher elasticities, but relative impacts of sector-specific results remained unchanged.

We also experimented with a wide range of land elasticities. Malpezzi and Maclennan (2001) estimated that the supply elasticity of land in post WWII in the U.S. is between 6 and 13. Similarly, Folian (1979) was unable to reject a perfectly horizontal long-run land supply curve for new construction. Blackley (1999) used annual U.S. data from 1950–94 and estimated long-run elasticities range between 1.6 and 3.7. Using English data, Pryce (1999) estimated a much

[5]We used four sources of data for workers per household. The Consumer Expenditure Survey (CES) provided estimates of workers per household for eight different household groups distinguished by income for different regions in the U.S. Also, the State Demographer's Office in Colorado had done survey work to determine these values. They also reviewed a third source, the 1990 U.S. Census and concluded that the CES national estimate of workers per household was a good estimate for Fort Collins. The Economic Profile System of the Sonoran Institute (2005), developed by the Bureau of Land Management, also provided estimates of workers per household for Fort Collins were consistent with the numbers used in our study.

smaller land elasticity of 0.75 during economic expansions and 0.58 during downturns. With elasticities between 1.0 and 5.0, the qualitative results of our analysis were not impacted significantly. Larger elasticities resulted in greater economic impact for any given simulation but the relative sector impacts remained the same.

Greenwood and Hunt (1984) estimated the percentage of new jobs in a city filled by new residents across many cities in the U.S., and found the range to be between 20 and 80 percent. On average, the larger eastern (Cleveland and Pittsburgh) and Midwest (Chicago and Detroit) cities had relatively low estimates for in migrants taking new jobs, while smaller cities (Portland, OR and Nashville) had larger elasticities. This is a key parameter, where the choice of level leads to large variations in outcomes.

In our base simulations, we have used land elasticities of 2.5, the range of labor supply elasticities used by Berck et al. (1996), and migration elasticities that result in 70 percent of the new jobs filled by new households. The migration elasticities resulting in the 70 percent solution were consistent with the Schachter and Althaus (1989) estimated elasticities for in-and out-migration with respect to changes in real income and unemployment. For in-migration, the real income elasticity, $\text{ETAYD}_{\text{I,H}}$, is 4.61 and the elasticity for the unemployment component $\text{ETAU}_{\text{I,H}}$ is -2.7. In the sensitivity analysis at the end of this section, we explore the consequences allowing 20 percent of new jobs to go to new migrants into the city versus the 80 percent case.

Impacts of Sector-Specific and Population-Led Growth

This section presents the results of our four simulation exercises. First, the general economic effects, including how different expansions affect economic growth in the city and the tax revenues obtained, are examined. Secondly, considerably different outcomes in regard to the labor market and distribution of income arise, so these are also reviewed in separate sections below.

General Economic Impacts

Table 3 presents the general economic impacts for the four simulations. The expansion in the high-wage sector leads to the greatest change in Gross City Product (GCP); a measure defined similarly to GDP but for a small region, and overall tax revenue, which is about 50 percent larger than the gains seen for general manufacturing. One particular aspect of the high-wage increase is use tax revenue gains, which come from imported capital equipment. It is evident from the fourth row in Table 3 that imported capital is a minor part of tax revenue in either the population-led simulation or when retail growth occurs. The manufacturing simulation leads to approximately twice the increase in GCP as the retailing expansion, which is due to a larger employment multiplier. However, the sales tax generated in the retail expansion leads to a larger increase in total tax revenue than when manufacturing grows. The increase in

TABLE 3: The Economic Impact on the Fort Collin Economy of Sector-Specific Expansions

	Manufacturing	High Wage	Retail	Population
Gross city	50.0	96.3	25.7	41.6
Product*	(2.2%)	(4.2%)	(1.1%)	(1.8%)
Total taxes*	3.1	4.6	3.6	0.74
	(3.6%)	(5.3%)	(4.1%)	(0.84%)
Sales tax*	0.93	1.3	2.8	0.39
	(2.4%)	(3.4%)	(7.2%)	(1.0%)
Use tax*	1.1	1.7	0.27	0.09
	(14.1%)	(21.5%)	(3.5%)	(1.2%)
New households	577	882	375	700
Land (Acres)	175.4	326	93.3	154.4
Per household and per acre measures ($)				
Taxes per new household	$5,386	$5,238	$9,550	$1,052
Taxes per acre	$17,721	$14,172	$38,355	$4,767
Household income per acre	$19,801	$17,884	$76,323	−$14,580

*Millions of Dollars.

GCP for population-led growth is about equivalent to that of manufacturing. New households demand more goods and services, leading to the increase in GCP, but this is partially offset by deceased wage rates from the added population. (See Table 4 for specific values). Tax revenue in this simulation is far below that in the sector-led expansions.

Other variations in economic impacts can be seen in the measures reported in the bottom of Table 3. The high-wage simulation creates the most new households and acres used. This large, absolute in-migration of new, high income households leads to the large gain in GCP. From a developer's perspective, this would be the most desirable outcome as there is the greatest physical expansion of the city. However, from the perspective of the city, the retail simulation produces a potentially attractive outcome, as tax revenue per new household is maximized and thus permits the greatest increase in the quality of services offered by the city. This is especially so because the retail sector creates the greatest sales tax revenues and also has the smallest increase in new households, so the most tax revenue per new household is available.

The retail case also has the largest increase in tax revenue per acre. Since retailing pays relatively low wages, the in-migration of households is small and the amount of new land developed is also small. Combined with the tax intensive nature of retailing, tax revenue per acre ends up large. These variations have significant implications for policy makers. In areas with tax limitation policies in place and antigrowth sentiment, pushing for retail expansion, especially if it can lead to tax revenues from outsiders, can be attractive. (Growth of retailing is, however, often seen as a manifestation of the ascendance of progrowth forces.)

TABLE 4: Impact of Sector-Specific Expansions on Employment for Selected Sectors and Wages

	Manufacturing (No. of Workers)	High Wage (No. of Workers)	Retail (No. of Workers)	Population (No. of Workers)
Retail	−25	45	1000	71
FIRE	−60	−46	−54	50
Lodging	−30	−17	−33	13
Restaurants	79	204	−17	90
Low Services	181	284	33	73
High Services	77	253	−18	114
Total	*1,207*	*1,830*	*786*	*880*
Employment Multiplier	1.2	1.8	0.78	
Percentage Change in Wages and Prices				
Wage Rate "L1"	1.42%	0.46%	1.84%	−0.55%
Wage Rate "L2"	1.03%	0.82%	0.20%	−0.42%
Wage Rate "L3"	0.66%	3.85%	0.16%	−0.47%
CPI	0.36%	0.48%	0.04%	−0.004%

Notes:
(1) L1 refers to workers earning less than $20,000 annually.
(2) L2 refers to workers earning more than $20,000 and less than $50,000 annually.
(3) L3 refers to workers earning $50,000 and above.

Somewhat surprisingly, the high-wage case has the smallest increase in household income and tax revenue per acre among the employment-led scenarios. As presented in Table 4, real wages for labor group L1 fall (explored below), which adversely affects all low-income households in the city and mutes household demand. However, this case leads to the largest increase in households and economic activity and thus the largest relative increase in land usage. The combination of small income gains for the lower income households and the large land use leads to small values for income and tax revenue per acre for the high-wage case.

Labor Market Variations

The impact of the four simulations on total employment and employment within selected sectors appears in Table 4. The high-wage expansion has the largest effect on employment, with a multiplier of 1.8. The most dramatic case is the retail expansion, where the employment multiplier is 0.78, which means that net growth in employment is less than the original 1,000 workers added as a direct increase in that simulation. An insufficient number of new households migrate into the area, so the retail sector needs to compete for workers from other sectors. Finance, Insurance and Real Estate (FIRE), lodging, restaurant, and high services sectors lose a total of 122 workers to the expanding retail sector. For the manufacturing and high-wage sector expansions, the employment multipliers are greater than unity as a sufficient number of new households enter the economy, so that the loss of employment in other sectors is minimal. The redistribution of workers from one sector to another is due to changes in relative prices and highlights the advantage of a CGE model in this type of analysis.

For all three employment-led simulations, the lodging and FIRE sectors lose workers. Lodging is primarily fueled by export demand, which does not grow in that sector. Therefore, the sector becomes less competitive than the expanding sectors because it faces higher labor costs, but does not see much opportunity to increase output prices because of its dependence on export demand.

The loss in workers in the FIRE sector is due to a similar competitive condition, as that sector depends on imports to meet local demand. The larger the relative proportion of imports in the supply of a sector, the more sensitive are the imports to changes in local prices. The domestic portion of total demand (D_i) is seen in equation (14) in the Appendix to be a function of a base proportion ($D0_i$) and, inversely, through a negative elasticity (ETAD), the relative domestic producer prices (PD_i) versus world import prices ($PWM0_i$). Thus a high dependence on imports, reflected in a low $D0_i$, will lead to a large decline in the domestic portion of a sector's demand as the local price rises. Imports grow as the domestic proportion declines, which is captured in equation (15).

The import supply elasticities in our model are based on the proportion of total domestic demand that is supplied from imports. Therefore, FIRE, which has a large proportion of imports, has an import supply elasticity of 7.6, but high services has import supply elasticity of 0.68 because most of its local demand is supplied by local producers. As the demand for FIRE increases in a simulation, its local price increases, resulting in a relatively large substitution into imports. Thus local resources are released as FIRE employment decreases, and expansion in other sectors is supported.

The population simulation leads to an increase in employment across all sectors as labor supply schedules shift outward. However, there is also a decrease in wages across the three labor groups, which can be seen in the bottom panel of Table 4. The reduction in wages lowers the expansion as local residents are adversely affected. The result is that tax revenue per acre, tax revenue per household, and income per household are smallest in this simulation. In fact, because of falling wages in the city, household income per acre actually declines.

The bottom part of Table 4 presents the wage rate implications. In the employment-led simulations, the direct effects emanating from increased employment opportunities cause nominal wages to rise, and all workers benefit to various degrees, so that gains are usually larger than in the population-led simulation. The change in the city CPI is also presented to gauge the changes in real wages. However, as new households move into the city, there is a component of in-migration that acts like the population-led simulation. As Table 2 presents, workers per household are as high as 2.1 in HH6. As a HH6 household migrates into the city, an additional 1.1 workers above the primary job holder seek employment. This effect has an impact similar to the population-led simulation, where labor supply exceeds labor demand at the prevailing wage. We will refer to this component as residual supply. The question is whether this residual supply, which has a depressing effect on wages, is large enough to offset the gains in wages from the direct employment effect specified in the three employment-led simulations.

The relative sizes of the direct and residual supplies are easily seen by comparing the manufacturing and high-wage sector expansions. As Table 4 indicates, real wages increase for the three labor groups in the manufacturing case as the increase in nominal wages is larger than the increase in the CPI. However, in the high-wage case, the nominal wage increases by a smaller amount than the increase in the CPI for L1 workers. The residual supply thus dominates the direct effect for L1 in the high-wage case. The underlying factors for these results can be seen from several different perspectives. The top part of Table 4 reports that the expansion in employment for the manufacturing simulation in low and high services, restaurants, etc. is partially supported by workers bid away from retail, lodging and FIRE sectors, and others. There are 115 workers bid away from these sectors in this simulation, while only 63 leave in the high-wage expansion. The increase in total employment is considerably lower in the manufacturing case, so that the greater number of workers taken from other sectors indicates that the demand for labor exceeds the available supply at the base wage rate and wages rise.

In the high-wage case, the increase in the supply of labor is relatively large for the L1 laborers. The employment growth for the manufacturing simulation is 0.9 percent, while the increase in households is 3.0 percent. In the high-wage case, employment increases by 1.4 percent, while household growth increases by 4.6 percent. The larger absolute difference between employment and household growth in the high-wage case leads to a relatively larger excess supply of labor. HH6 households have the largest number of workers per household (see Table 2), so many L1 workers are found as second wage earners, leading to a further increase in the supply of low-wage workers. Thus, the residual supply is relatively greater than the direct employment demand for low wage workers, so the rise in L1 nominal wages is relatively small. Since the city CPI increases by 0.48 percent and the nominal wage for L1 increases by 0.46 percent, the real wage falls for this labor group in the high-wage case. The fall in real wages for L1 also has a negative impact on real household income. Referring back to Table 3, the relatively large increase in land use leads to real household income per acre to be the smallest for the high-wage case among the employment-led simulations.

The effect on wages in the retail simulation is more straightforward. Since 87 percent of the workers in retail are in the L1 category, the 1,000-employee expansion will primarily bid up wages for this group. As Table 4 indicates, nominal wages for L1 increase by 1.84 percent while small changes occur for L2 and L3 and the increase in the CPI is negligible.

Effects on the Distribution of Income

To assess the total impact on households, land and capital income must be added to the labor income sources discussed above. We first consider changes in levels of real household income and then look at the change in its distribution. Real household income for the *original* residents is examined here because this group votes on policies regarding new firms and restrictions on new households migrating into the city, and therefore, they should be aware of how the different scenarios affect them.

Table 5 presents these results, which are perhaps somewhat unexpected. The largest gain in total real household income occurs in the retail simulation, which exceeds the high-wage results by \$1.3 million and is nearly double the real income gains to the original residents found in the manufacturing simulation. These results reflect three important factors. The retail simulation is partially fueled by an increase in capital, which reduces the price of retail goods within Fort Collins. Since retailing expenditures are an important component of household consumption, this price effect offsets upward pressure on the city CPI from other growth factors, and as Table 4 indicates, the CPI only increases by 0.04 percent. The CPI in the manufacturing and high-wage simulations rises by considerably larger amounts, which reduces real income gains.

The second factor is that the retail expansion only brings in 375 new households, which results in increased competition for local workers. (We vary this outcome in the next section). The result is upward pressure on wages for L1 workers. The combination of the small increase in the CPI and increased competition for workers gives the largest increase in real income in the retail simulation. An additional factor is that, in all three employer-led simulations, it was assumed that wages for Colorado State University (CSU) employees were unaffected as this labor market is determined outside the city. While CSU is the largest employer in the city, the wage gains for L2 and L3 in the manufacturing and high-wage cases do not benefit CSU employees, so that many original residents do not see the wage increases listed in Table 4.

The impact on the distribution of real household income reveals that, for the manufacturing and retail-led growth cases, the percentage increase in real income is larger for lower income households than for the upper groups; however, the absolute changes in real income are still greater for the upper income households. Policy makers have the option to try to stimulate sectors that provide direct assistance to lower-income groups, or they can allow the sectors with the highest growth potential to expand, and then make use of policies to compensate losers and improve welfare for lower income households. We examine these options in the conclusion.

The high-wage case reveals that household group HH2 actually loses real income as the supply of labor grows above the new demand for the lowest-wage group, and the simulation has a relatively large increase in CPI. As seen above, when Fort Collins attempts to attract high paying jobs, the accompanying large

TABLE 5: Impact on the Distribution of Real Income for Original Residents

	Manufacturing		High Wage		Retail		Population	
	Real Income (mil of $)	Percent Change	Real Income (mil of $)	Percent Change	Real Income (mil of $)	Percent Change	Real Income (mil of $)	Percent Change
HH1	0.129	0.96%	0.018	0.13%	0.245	1.83%	−0.045	−0.34%
HH2	0.435	0.48%	−0.101	−0.11%	0.926	1.02%	−0.293	−0.32%
HH3	0.600	0.35%	0.316	0.19%	1.063	0.62%	−0.352	−0.21%
HH4	0.260	0.36%	0.173	0.24%	0.462	0.63%	−0.121	−0.17%
HH5	0.793	0.38%	0.828	0.40%	1.678	0.81%	−0.333	−0.16%
HH6	1.256	0.27%	4.599	0.97%	2.746	0.58%	−1.106	−0.23%
Total	*3.473*		*5.832*		*7.120*		*−2.250*	

Notes: Household Groups: HH1 ≤ \$10,000; \$10,001 ≤HH2 ≤ \$20,000; \$20,000 < HH3 ≤ \$40,000; \$40,000 < HH4 ≤ \$50,000; \$50,000 < HH5 ≤ \$70,000; \$70,000 < HH6.

increase in second income earners in a family has a depressing effect on wages in some labor groups. However, the figures suggest that it would be possible, at least potentially, to compensate lower income households with the gains from the upper group. Also, some of this negative effect is occurring within the HH6 households themselves, so presumably, redistribution is taking place informally. Of the 1,319 new workers in the high-wage simulation, 257 L1 and 201 L2 workers come from HH6 households, because of the residual supply of labor discussed earlier. Thus, over one-third of the new low income workers are from HH6 households.

Our results offer a refinement to Bartik (1994), who estimated that total employment growth increases income for the lowest quintile group by a greater amount than for the highest group. We maintain that alternative *sources* of employment-led growth have different impacts on wage/income inequality, as well, when growth is led by retailing or manufacturing, then wage/income inequality is reduced, which supports Bartik. However, when a high-paying sector leads economic growth, in-migration of households is large enough such that real wages for the lowest income households may actually fall and wage/income inequality increases. Since Bartik only considered the impact of total employment, he was unable to observe this effect.

Another supporting study is Quercia, Stegman, and Davis (2002), who used 1999 survey data to examine the economic impact of the technology boom on affordable housing and the distribution of household income for lower- and middle-income families. They determined that this boom resulted in price increases in housing that outstripped income growth of lower and middle-income households, thus reducing the affordability of housing. In addition, they find an increase in income inequality. Therefore, these results support the conclusions reached in our high-wage simulations.

Sensitivity Analysis

This section examines the impact of considering low migration elasticities, where only 20 percent of new jobs are filled by new residents, with the upper bound case of 80 percent of new jobs filled by new households. The first data column of Table 6 presents the change in the level of real household income for *original* residents across the three employment-led simulations for the 20 and 80 percent cases. The percentage change in income is in parentheses. The percent of total column represents the percent of total income that each household group earns relative to total real income earned by the original residents.

In general, when the percentage of new jobs filled by migrating households is low, there is a smaller increase in labor supply and, thus, greater upward pressure on wages and larger increases in real household income. As an example, total real household income in the manufacturing simulation increased by \$4.32 million for the 20 percent case but only \$2.83 million for the 80 percent case. The most dramatic case is for retail, where real income comes close to doubling when the two cases are compared. The growth in retail

TABLE 6: Impact of Different Migration Elasticities on Real Household Income (Original Residents)

	Manufacturing		Manufacturing		High Wage		High Wage		Retail		Retail	
	20%		80%		20%		80%		20%		80%	
Households	Real Income (mil of $)	Percent of Total	Real Income (mil of $)	Percent of Total	Real Income (mil of $)	Percent of Total	Real Income (mil of $)	Percent of Total	Real Income (mil of $)	Percent of Total	Real Income (mil of $)	Percent of Total
HH1	0.204	4.7	0.095	3.4	0.12	1.8	−0.04	−0.8	0.34	3.0	0.20	3.1
	(1.5%)*		(0.71%)		(0.93%)		(−0.29%)		(2.5%)		(1.5%)	
HH2	0.800	18.5	0.27	9.6	0.42	6.1	−0.37	−7.6	1.42	12.6	0.73	11.1
	(0.88%)		(0.30%)		(0.46%)		(−0.41%)		(1.6%)		(0.81%)	
HH3	0.812	18.8	0.469	16.6	0.56	8.2	0.15	3.0	1.99	17.6	0.94	14.3
	(0.48%)		(0.28%)		(0.33%)		(0.09%)		(1.2%)		(0.55%)	
HH4	0.322	7.5	0.215	7.6	0.23	3.4	0.12	2.5	0.74	6.6	0.43	6.4
	(0.44%)		(0.33%)		(0.32%)		(0.17%)		(1.0%)		(0.58%)	
HH5	0.923	21.3	0.68	24.1	0.95	13.8	0.68	14.0	2.63	23.3	1.59	24.0
	(0.45%)		(0.29%)		(0.46%)		(0.33%)		(1.3%)		(0.76%)	
HH6	1.264	29.2	1.1	38.8	4.60	66.7	4.34	88.9	4.16	36.9	2.72	41.1
	(0.27%)		(0.23%)		(0.97%)		(0.92%)		(0.88%)		(0.58%)	
Total	4.32	100.0	2.83	100.0	6.89	100.0	4.88	100.0	11.29	100.0	6.61	100.0

Notes: *Refers to the percentage change in household income relative to the base.

primarily raises the demand for L1 workers, so wage increases have to be higher to get the increase to 1,000 workers. Therefore, imposing the lower migration elasticity causes a substantial wage increase for L1 workers, who are the most abundant labor group in the economy. By contrast, the manufacturing simulation produces a more even demand across the three labor groups so migration restrictions can be imposed with a smaller increase in household income. Thus, municipalities that have lower migration elasticities will experience relatively larger increases in household income for any given exogenous shock.

The most interesting result of these simulations concerns the high-wage sector. For regions that have large migration elasticities, we obtain our previous result that real income falls for the lower income earning households. However, for regions or cities that fall into the 20 percent category, probably older industrial cities with fewer amenities, the relatively small increase in labor supply results in real household income gains across all household groups.

The last column for each case describes the percentage of the increase in income that each household group receives. The retail case reports that HH1 receives an essentially unchanging proportion of total income in the two cases. It appears that while the reduction in migration causes total income to increase, the household groups that gain relative to the total are HH2 and HH3. In both the manufacturing and high-wage cases, HH1–HH3 gain considerably in the 20 percent case compared to the 80 percent case.

Tax revenue per household is also sensitive to the level of household migration. For the 20 percent case, the tax revenue per household for manufacturing, high-wage and retail simulations are \$34,490, \$33,067 and \$56,263, respectively. For the 80 percent case, the numbers are \$3,910, \$3,717 and \$31,282, respectively. Regardless of the intensity of migration, the retail case still permits the city the greatest opportunity to increase the quality of its services. However, the differences in outcomes when the levels of migration are high or low can be quite large.

4. POLICY IMPLICATIONS AND CONCLUSION

This paper employed a data intensive CGE model to highlight that substantial variation exists when sector-specific changes in employment opportunities occur. We examined the differences in general economic growth, land usage, the distribution of household income, migration, and the efficiency of raising tax revenue. These wide ranges of outcomes pose complex problems for the policy maker in decisions about what sectors should be encouraged to expand.

Expansion of the high-wage sector led to the largest increase in economic growth and tax revenue, and it created a more diversified labor pool as well as a demand for a wider range of products. The positive agglomeration effects are a desirable outcome of this simulation. From the perspective of local builders, expanding the high-wage sector is most desirable. However, the retail expansion led to the largest increase in tax revenue per acre and also household income per acre. The retail simulation would allow the largest expansion in the quality of city services.

Our paper also demonstrated the economic gains versus equity outcomes when different sectors expand. One question concerns the criteria that should be used to evaluate which sector expansions offer the most to a municipality. We have seen that on average, the percentage increases for real income are greater for lower income households (HH1 and HH2) in the retail and manufacturing simulations for a majority of migration elasticities. However, the absolute gains are greater for the upper income households (HH5 and HH6). While of doubtful tolerance for a policy maker, if these percentage differences were to persist, it would take 40–50 years for the absolute differences to be larger for HH1 and HH2 relative to HH5 and HH6. Our analysis indicates that there are no adequate options for promoting economic growth whereby low-income households can gain in absolute terms.

Low income households could in principle benefit if the local government considers some form of compensation to offset losses. Redistributing the larger economic gains from upper-income households to lower-income households can take several forms. The increase in tax revenue could be used to create more affordable housing for lower-income households, something that has been on the agenda in the city. This might be particularly useful in the high-wage case, where the largest gains in tax revenue occur but also where low-income households experience losses in real income. Secondly, local income taxes that are progressive could be used to fund city services. However, in Colorado, a particularly stringent tax limitation amendment, the Taxpayers Bill of Rights (TABOR) exists, which severely constrains the growth of any new taxes. Fort Collins does not have an income tax and will not be able to add one any time soon. It may be that the most direct method of improving the outcomes for lower-income households would be to restrict in-migration to be closer to the 20 percent case we illustrated earlier. In that case, we saw significant gains going to lower-income households. This would likely meet opposition from developers, who would favor the high-wage outcome with its large increase in housing demand and industrial activity.

One mitigating dimension found in our analysis was seen in an identified household dynamic, where high-wage earners, L3, are often paired with an L1 worker in the same household. In a sense, compensation may be occurring within the HH6 household. As an HH6 household moves into the city, the accompanying L1 worker earns less in the high-wage case, but compensation is occurring within this household due to higher wages for the L3 worker.

We maintain that our results should be relevant to any of the fast growing areas such as Portland, OR, Salt Lake City or Albuquerque. Given that these areas all have desirable physical characteristics, and elasticities used in this analysis would probably be similar, our results could probably be generalized. Specifically, as small cities and towns attempt to attract either high-wage or retail sectors, the results of this paper could be of value.

REFERENCES

AARP Magazine, May and June 2003, Website: www.aarpmagazine.org

Bartik, Timothy J. 1993. "Who Benefits Form Local Job Growth: Migrants or the Original Residents," *Regional Studies,* 27(4), 297–311.

———. 1994. "The Effects of Metropolitan Job Growth on the Size Distribution of Family Income," *Journal of Regional Science,* 34(4), 483–501.

Berck, P., E. Golan, and B. Smith. 1996. *Dynamic Revenue Analysis for California*. Sacramento, CA: California Department of Finance.

Blackely, Dixie M. 1999. "The Long-Run Elasticity on New Housing Supply in the United States: Empirical Evidence for 1950 to 1994," *The Journal of Real Estate Finance and Economics*, 18(1), 25–42.

Blanchard, Olivier Jean and Lawrence F. Katz, 1992. "Regional Evolutions," *Brookings Papers on Economic Activity,* 1, 1–76.

U.S. Department of Labor Bureau of Labor Statistics. 1996. *Consumer Expenditure Study*. Washington, DC: U.S. Department of Labor Bureau of Labor Statistics.

Economic Profile System of the Sonoran Institute. 2005. Bureau of Land Management. www.Sonoran.org/programs/socioeconomics/. Employment Review, June 2002.

Follain, James R., Jr. 1979. "The Price Elasticity of the Long-Run Supply of New Housing Construction," *Land Economics*, 55(2), 190–199.

Freeman, Donald G. 2001. "Sources of Fluctuations in Regional Growth," *The Annals of Regional Science,* 35, 249–266.

Greenwood, Michael J. and Gary L. Hunt. 1984. "Migration and Interregional Employment Redistribution in the United States," *American Economic Review,* 74(5), 957–969.

Levernier, William, Mark D. Partridge, and Dan S. Rickman. 1998. "Differences in Metropolitan U.S. Family Income Inequality: A Cross County Comparison," *Journal Urban Economics,* 44, 272–290.

Malpezzi, S. and D. Maclennan 2001, "The Long-Run Price Elasticity of Supply of New Residential Construction in the United States and the United Kingdom," *Journal of Housing Economics*, 10, 278–306.

Mathur, Vijay K. and Frank M. Song. 2000. "A Labor Market Based Theory of Regional Economic Development," *The Annals of Regional Science,* 34, 131–145.

The Men's Journal, April 2005, WENNER MEDIA: RollingStone.com | UsOnline

Partridge, Mark D. and Dan S. Rickman. 2003. "The Waxing and Waning of Regional Economies: The Chicken-Egg Question of Jobs Versus People," *Journal of Urban Economics,* 53, 76–97.

Porter, Michael E. 2003. "The Economic Performance of Regions," *Regional Studies* 37, 549–578.

Pryce, Gwilym, 1999. "Construction Elasticities and Land Availability: A Two-stage Least-Squares Model of Housing Supply Using the Variable Elasticity Approach," *Urban Studies*, 36(13), 2283–2304.

Quercia, Roberto G., Michael A. Stegman, and Walter R. Davis. 2002. "Does a High-Tech Boom Worsen Housing Problems for Working Families," *Housing Policy Debate,* 12(2), 393–415.

Schachter, Joseph and Paul Althaus, 1989. "An Equilibrium Model of Gross Migration," *Journal of Regional Science*, 29(2), 143–159.

Schwarm, Walter and Harvey Cutler. 2003. "Building Small City and Town SAMs and CGE Models," *Review of Urban and Regional Development Studies,* 15(2), 132–146.

———. 2005. "Multiple Labor Groups and Their Effects on Small City and Town SAMs and CGE Models," *Review of Urban and Regional Development Studies,* 17(2), 162–176.

APPENDIX

Equations

HOUSEHOLDS

(1) $$CPI_H = \Sigma_I P_I * (1+\Sigma_{GS} TAUC_{GS,I}) * CH_{I,H} / \Sigma_I (P0_I * (1+\Sigma_{GS} TAUQ_{GS,I})) * CH_{I,H};$$

(2) $$\begin{aligned} Y_H = {} & \Sigma_L A_{H,L} * HW_H / \Sigma_{H1} A_{H1,L} * HW_{H1} * \\ & (Y_L + (CMIWAGE_L) * CMI_L)) * (1-\Sigma_G TAUFL_{G,L})) \\ & + A_H COMMO * CMOWAGE_L * CMO_L \\ & + \Sigma_{LA} A_{H,LA} * HW_H / \Sigma_{H1} A_{H1,LA} * HW_{H1} * \\ & (Y_{LA}) + LNFOR_{LA}) * (1-\Sigma_G TAUFLA_{G,LA})) \\ & + \Sigma_K A_{H,K} * HW_H / \Sigma_{H1} A_{H1,K} * HW_{H1} \\ & * (Y_K + KPFOR_K) * (1-\Sigma_G TAUFK_{G,K}); \end{aligned}$$

(3) $$YD_H = Y_H + PRIVRET_H * HH_H + \Sigma_G TP_{H,G} * HH_H - \Sigma_{GI} PIT_{GI,H} * HH_H - \Sigma_G TAUH_{G,H} * HH_H;$$

(4) $$CH_{I,H} = CH0_{I,H} * ((YD_H/YD0_H)/(CPI_H/CPI0_H))^{BETA} I, H * \Pi_J (P_J * (1+\Sigma_{GS} TAUC_{GS,J})/(P0_J * (1+\Sigma_{GS} TAUQ_{GS,J})^{LAMBDA}_{J,I};$$

(5) $$S_H = YD_H - \Sigma_I P_I * CH_{I,H} * (1+\Sigma_{GS} TAUC_{GS,I});$$

PRODUCERS

(6) $$PVA_I = PD_I - \Sigma_J AD_{J,I} * P_J * (1+\Sigma_{GS} TAUQ_{GS,J});$$

(7) $$DS_I = DELTA_I * \Pi_F (FD_{F,I} {}^{ALPHA}_{F,I});$$

(8) $$R_{F,I} * RA_F * (1+\Sigma_{GF} TAUFX_{GF,F,I}) * FD_{F,I} = PVA_I * DS_I * ALPHA_{F,I};$$

(9) $$V_I = \Sigma_J AD_{I,J} * DS_J;$$

(10) $$Y_L = \Sigma_{IG} (R_{L,IG} * RA_L * FD_{L,IG});$$

(11) $Y_K = \Sigma_{IG}(R_{K,IG} * RA_K * FD_{K,IG});$

(12) $Y_{LA} = \Sigma_{IG}(R_{LA,IG} * RA_{LA} * FD_{LA,IG});$

TRADE

(13) $CX_I = CX0_I * ((PD_I(1 + \Sigma_{GK} TAUX_{GK,I}))/(PW0_I(1 + \Sigma_{GK} TAUQ_{GK,I})))^{ETAE}{}_I;$

(14) $D_I = D0_I * (PD_I/PWM0_I(1 + \Sigma_{GK} TAUM_{GK,I}))_I^{ETAD};$

(15) $M_I = (1 - D_I) * DD_I;$

(16) $P_I = D_I * PD_I + (1 - D_I) * PWM0_I(1 + \Sigma_K TAUM_{GK,I});$

(17)
$$\begin{aligned} NKI = {} & \Sigma_I M_I * PWM0_I - \Sigma_I CX_I * PD_I - \Sigma_H PRIVRET_H * HH_H \\ & - \Sigma_{LA} LNFOR_{LA} - \Sigma_K KPFOR_K - \Sigma_G GVFOR_G \\ & - \Sigma_L CMOWAGE_L CMO_L - \Sigma_L CMIWAGE_L * CMI_L; \end{aligned}$$

INVESTMENT

(18) $N_{K,I} = N0_{K,I} * (R_{K,I}/R0_{K,I})_{K,I}^{ETAIX} * (DS_I/DS0_I)_{K,I}^{ETAIX1};$

(19) $P_I * (1 + \Sigma_{GS} TAUN_{GS,I}) * CN_I = \Sigma_{IG} B_{I,IG} * (\Sigma_K, N_{K,IG});$

(20) $KS_{K,IG} = KS0_{K,IG} * (1 - DEPR) + N_{K,IG});$

FACTOR SUPPLY

(21)
$$\begin{aligned} HW_H/HH_H = {} & HW0_H/HH0_H * ((\Sigma_L RA_L)/RA0_L))/3)/(CPI_H/CPI0_H) \\ & * (\Sigma_{Z,L} FD_{L,Z})/(\Sigma_{H1} HW_{H1} * \Sigma_L JOBCOR_{H1,L} + \Sigma_L CMI_L) \\ & + \Sigma_L EXWGE_{2L}/RA_L)/3 \\ & * (\Sigma_L CMO_L/(\Sigma_{H1} HW_{H1} * \Sigma_L JOBCOR_{H1,L} + \Sigma_L CMI_L))_H^{ETARA} \\ & * (\Sigma_G TP_{H,G}/CPI_H/(\Sigma_G TP_{H,G}/CPI0_H))_H^{ETAPT}; \end{aligned}$$

(22) $CMO_L = CMO0_L * (EXWGE1_L/RA_L)_L^{ECOMO};$

(23) $CMI_L = CMI0_L * (RA_L/EXWGE2L)_L^{ECOMI}$;

(24) $LAS_{LA,I} = LAS0_{LA,I} * (R_{LA,I})/R0_{LA,I})_{LA,I}^{ETAL} * (DS_I/DS0_I)_{LA,I}^{ETAL1}$;

(25) $HH_H = HH0_H * NRPG_H + MI0_H * ((YD_H/HH_H)/(YD0_H/HH0_H)$
$/(CPI_H/CPI0_H))_H^{ETAYD} * ((HN_H/HH_H)/(HN0_H/HH0_H))^{ETAU}H$
$-MO0_H * ((YD0_H/HH0_H)/(YD_H/HH_H)/(CPI0_H/CPI_H))^{ETAYD}H$
$* ((HN0_H/HH0_H)/(HN_H/HH_H))^{ETAU}H$;

(26) $HN_H = HH_H - HW_H$;

GOVERNMENT

(27) $Y_{GX} = \Sigma_I TAUV(GX, I) * V(I) * P_I + \Sigma_I TAUX_{GX,I} * CX_I * PD_I$
$+ \Sigma_I TAUM_{GX,I} * M_I * PWM0_I + \Sigma_{H,I} TAUC_{GX,I} * CH_{I,H} * P_I$
$+ \Sigma_I TAUN_{GX,I} * CN_I * P_I + \Sigma_{GN,I} TAUG_{GX,I} * CG_{I,GN} * P_I$
$+ \Sigma_{F,I} TAUFX_{GX,F,I} * RA_F * R_{F,I} * FD_{F,I}$
$+ \Sigma_{F,GN} TAUFX_{GX,F,GN} * RA_F * R_{F,GN} *$
$FD_{F,GN} + \Sigma_L TAUFH_{GX,L} * (Y_L + CMIWAGE_L * CMI_L)$
$+ \Sigma_K TAUFH_{GX,K} * Y_K + \Sigma_{LA} TAUFH_{GX,LA} * Y_{LA}$
$+ \Sigma_H PIT_{GX,H} * HH_H + \Sigma_H TAUH_{GX,H} * HH_H + \Sigma_{GX1} IGT_{GX,GX1}$;

(28) $P_I * (1 + \Sigma_{GS} TAUG_{GS,I}) * CG_{I,GN} = AG_{I,GN} * (Y_{GN} + GVFOR_{GN})$;

(29)
$FD_{F,GN} * R_{F,GN} * RA_F * (1 + \Sigma_{GF} TAUFX_{GF,F,GN}) = AG_{F,GN} * (Y_{GN} + GVFOR_{GN})$;

MODEL CLOSURE

(30) $\Sigma_H HW_H * JOBCOR_{H,L} + CMI_L = \Sigma_Z FD_{L,Z} + CMO_L$;

(31) $KS_{K,IG} = FD_{K,IG}$;

(32) $LAS_{LA,IG} = FD_{LA,IG}$;

(33) $DS_I = DD_I + CX_I - M_I$;

(34) $DD_I = V_I + \Sigma_H CH_{I,H} + \Sigma_G CG_{I,G} + CN_I$;

Indices

$_I$ = private sector

$_{IG}$ = private sectors and local government services

$_F$ = factors (L1,L2,L3, KAP and Land)

$_L$ = L1, L2 and L3

$_{LA}$ = Land Categories

$_K$ = Capital Categories

$_H$ = HH1, HH2, HH3, HH4, HH5 and HH6

$_G$ = all governments

$_{GN,GS,GX}$ = indices of different tax jurisdictions

Variable Descriptions

$CG_{I,G}$ = local government consumption

$CH_{I,H}$ = household consumption

CMI_L = number of workers commuting out of city

CMO_L = number of workers commuting into the city

CN_I = investment by sector of source

CPI_H = consumer price index across households

CX_I = export demand

D_I = domestic supply share of domestic demand

DD_I = domestic demand

DS_I = domestic supply

$FD_{F,Z}$ = factor demand

$IGT_{G,GX}$ = intergovernmental transfers

$KS_{K,IG}$ = capital stock

$LAS_{LA,IG}$ = stock of land in acres

HH_H = total number of households

HN_H = number of nonworking households

HW_H = number of working households

M_I = imports

$N_{K,IG}$ = gross investment by sector

NKI = nominal net capital outflow

$KPFOR0_{K}$ = nominal capital outflow

$LNFOR0_{LA}$ = nominal land outflow

$GVFOR0_{G}$ = nominal government outflow

P_{IG} = aggregate prices paid by sectors

PD_{I} = domestic prices

PVA_{I} = value added prices

$PW0_{I}$ = export prices (demand shifter for export demand)

$PWM0_{I}$ = import prices

$R_{F,Z}$ = initial sector rental rate for factors

RA_{F} = average rental rater for factors

S_{H} = savings

SPI = total personal income

V_{I} = intermediate demand

$TP_{H,G}$ = social security payments

YD_{H} = disposable household income

Y_{H} = gross household income

Tax Rates

$TAUQ_{GS,I}$ = all tax rates

$TAUC_{GS,I}$ = sales tax rates and other local tax rates

$TAUM_{GS,I}$ = use tax rates

$TAUX_{GS,I}$ = export taxes

$TAUFX_{GF,F,Z}$ = labor taxes

$TAUFH_{GX,LA}$ = taxes on land

$TAUFH_{GX,K}$ = taxes on capital

$TAUH_{GX,H}$ = personal income tax rates

$TAUV_{GS,I}$ = taxes on intermediate goods

$TAUN_{GS,I}$ = taxes on investment goods

$TAUG_{GS,I}$ = federal taxes

Parameters

$BETA_{I,H}$ = income elasticity for demand

$LAMBDA_{J,I}$ = price elasticity

$DELTA_{I}$ = scale parameter for the production functions

$ALPHA_{F,I}$ = relative share of factors

$ETAE_I$ = elasticity for export demand

$ETAD_I$ = import supply elasticity

$ETAIX_{K,I}$ = price for investment

$ETAIX1_{K,I}$ = domestic supply elasticities for investment

$ETARA_H$ = labor supply elasticities for households

$ETAPT_H$ = elasticity of labor supply with respect to households

$ECOMO_L$ = elasticity of commuting out with respect to relative wages

$ECOMI_L$ = elasticity of commuting in with respect to relative wages

$ETAL_{LA,I}$ = elasticity of land supply with respect to rates of return

$ETAL1_{LA,I}$ = elasticity of land supply with respect to domestic supply

$ETAYD_H$ = elasticity of migration with respect to real household income

$ETAU_H$ = elasticity of migration with respect to the ratio of nonworking household to total households

$MI0_H$ = rate of in-migration

$MO0_H$ = rate of out migration