The Economic Consequences of Population-and Employment-Led Growth

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Abstract

The population/employment leader and follower issue has been a long studied issue across many different geographical regions in the U.S. What has not been investigated in any great detail is the economic consequences of having either population-or employment-led growth. We use a data-intensive computable general equilibrium (CGE) model and examine the impact on tax revenue, wage inequality and the use of land for population-led growth as well as growth led by a medium and high wage manufacturing sectors and retailing. With respect to wage/income inequality, we find additional support for Forbes' (2000) conclusion that economic growth and wage inequality are positively related in some common types of employment-led growth. We maintain that our results are general for many regions across the U.S. and pose significant decisions for local policymakers as they decide on the types of industries to attract to their municipality.

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An ongoing issue examined in the regional literature is whether employment follows population or the reverse.[1] Areas where employment follows population are usually associated with high levels of amenities, which originally entice households to migrate into the region and firms eventually follow. When population follows employment, employers initially move into a region to take advantage of low production costs and eventually households migrate into the region in response to the employment opportunities.

What has been ignored in the literature are the impacts of either employment-or population-led growth in areas such as tax revenue, the distribution of wage/income, prices and land usage. This paper is concerned with varying economic impacts of expanding sectors that have different characteristics. Alternatively, a high wage sector, computer manufacturing, a medium wage sector, manufacturing, and a lower wage sector, retailing are all examined as they affect economic growth. We also estimate the economic impact of population-led growth. The method used in this paper is based on a computable general equilibrium (CGE) model using more detailed data than is typically used in CGE analysis.

A central piece of the paper is how employment-and population-led growth affect wage/income inequality within a specific city. The wage inequality literature has gone in two distinct directions. One method has been to model wage inequality as the dependent variable and then determine what factors cause changes in this variable. The second approach uses wage inequality as an explanatory variable in the determination of economic growth. What is common to both approaches is that highly aggregated regional

[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).

or country data is used. As such, results from these analyses have limited use with respect to local policymakers.

Modeling wage inequality as a dependent variable has concentrated on the factors causing wage inequality. Borjas and Ramey (1995) use state level data to examine wage inequality across cities in the U.S. when changes occur in trade-impacted and concentrated industries. Nissan and Carter (1999) use income data for metropolitan and non-metropolitan areas and determine that the income gap decreased in the 1970s and increased in the 1980s. Nissan and Carter (2001) also examine the 51 largest cities in the U.S. and found that household income and producer services earnings diverged over the 1979-89 period. Levernier, Partridge and Rickman (1998) focus on 3,000 U.S. counties and independent cities and examine more detailed causes of wage inequality, such as changes in female head of household, migration flows and labor force participation rates for both males and females.

The second approach uses wage inequality as an explanatory variable and estimates its impact on economic growth. Interestingly, there is support for both positive and negative relationships between these variables. Benabou (1996) surveyed the literature and concluded that most of the research found an inverse relationship. Forbes (2000) argues that when a more complete panel data set is used, a positive relationship is obtained between wage inequality and economic growth.[2]

The use of wage inequality as either an endogenous or exogenous variable in the literature raises specification issues. This paper argues that economic growth and wage inequality are determined simultaneously as different growth scenarios can lead to

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[2] Benabou (1996), Forbes (2000), Deininger and Squire (1998) and Galor and Tsiddon (1997) explore theoretical reasons for both positive and negative relationships. Some of these issues will be explored in the simulation section of this paper.

dissimilar changes in the distribution of wages/income. We also argue that many of the factors impacting wage inequality are determined jointly and therefore, need to be estimated simultaneously. Instead of using an econometric approach, we use a CGE model that jointly solves for economic growth and wage/income inequality as well as the variables that influence wage/income inequality.

Our model contains seventeen different productive sectors that employ three labor groups distinguished by income. These laborers are then routed into six different household groups, also distinguished by income earned. We examine how changes in employment-and population-led growth impact income inequality across the original residents in the six household groups. Since original residents vote for policy, the consequences of how this group is affected by different types of employment-led verses population-led growth is important to understand. We maintain that these results provide useful insights to local policymakers as they consider offering incentives to manufacturers and retailers to enter the local economy. The relationship between economic growth and wage inequality is dependent upon the characteristics of the sector initially expanded as well as migration patterns of entering households as well as the length of time considered.[3]

We have collected an *extensive* data set for Fort Collins, Colorado, a city of 100,000 people in northern Colorado. We consider the medium and long-run economic impacts of expanding computer manufacturing, general manufacturing and retailing, all

[3] The use of CGE models to examine wage inequality issues is very limited. Kim and Kim (2002) examine four major regions in Korea and consider the effect of regional investment decisions on income inequality. Deepak, West and Spreen (2001) develop a CGE model that has skilled and unskilled workers, migration patterns, and regional unemployment rates. They examine changes in wage inequality in a wide range of policy simulations.

of which are compared to population-led growth. In an area like northern Colorado, expanding retail has become an important consideration as competition for sales tax revenue has become fierce. Whereas manufacturing has been typically considered an export industry, retail has started to develop similar export characteristics because of surrounding towns in the region and travelers passing through the area. Overall, we are interested in how employment-and population-led growth impact income inequality, tax revenue, and land usage.[4] Arguments are also made that results obtained in this paper can generalize too many high growth areas in the western U.S.

Section II presents a description of the CGE model used and the data collected. Section III presents the simulation results and section IV is the conclusion.

II. The CGE Model and Data

CGE Model

An extensive description of the CGE model and data collected is presented in Schwarm and Cutler (2003) so only several key features of the model and data are highlighted here. Table 1 presents a summary of the structure of the model. There are 17 productive sectors that demand the services of three labor groups, which are differentiated by income, capital and land. The private sectors maximize profits by choosing optimal levels of labor, capital and land. Six household groups are differentiated by income and they demand the goods produced by the sectors as well as demanding housing services. Housing services are divided into four categories; houses

[4] This paper was partially motivated by a request made by the City of Fort Collins to evaluate the economic impact of zoning a 60 acre plot of land for a Lifestyle Retail Center or a variety of different manufacturing plants. The new retail center combines retail and amusement type activities.

Table 1

Structure of the System

Profit Maximizing

1) Agriculture services
2) Agricultural production
3) Agricultural processing
4) Low services – hair, cleaners, etc.
5) High services – legal, medical
6) Construction
7) Manufacturing
8) Mining
9) Computer Manufacturing
10) Transportation and utilities
11) Communications
12) Wholesale
13) Retail
14) Finance, insurance and real estate (FIRE)
15) Forestry and Fisheries
16) Universities and JCs
17) School District

Housing Market

HS1 < $120,000
$120,000 < HS2 < $200,000
$200,000 < HS3
HS4- multiple units

Local Government

1) Services: Police, Fire, Transportation, Library, Parks and Recreation, and Administration
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 \$20,000 < L_2 # \$50,000 \$50,000 < L_3	K – buildings and factories used by the productive, residential and public use	Land – land used by the productive, residential, and public use (acres)

less than \$100,000 (HS1); houses between \$100,000 and \$200,000 (HS2); houses valued over \$200,000 (HS3); and multiple units such as apartments and condominiums (HS4). Households maximize utility as they purchase goods and services as well as supply labor. The local government provides services such as police, fire, transportation, library parks and recreation, and city administration. These expenditures are financed by the collection of sales, use, property and other taxes in the local economy. The state and federal governments are also modeled but are a minor part of the model.

Equation (1) highlights the uniqueness of our CGE model in terms of estimating household income across the six household groups (indexed by h). The expression on the

$$
\begin{aligned}
Y_h = {} & E_L(a_{h,L}HW_h)/(E_h\, a_{h,L}HW_h)\ ((Y_L + CMIW_L{*}\, CMI_L)(1 - \Gamma_G\, \vartheta_{g,L})) + \\
& A_{h,com}CMOW_LCMO_L + \qquad (1) \\
& E_{LA}(a_{h,LA}HW_h)/((E_h\, a_{h,LA}HW_h)(Y_{LA} + LNFOR_{LA})(1 - \Gamma_G\, \vartheta_{g,LA})) + \\
& E_k(a_{h,k}HW_h)/((E_h\, a_{h,k}HW_h))\ (Y_k + KPFOR_k)(1 - \Gamma_G\, \vartheta_{g,k}))
\end{aligned}
$$

first line of equation (1) represents earned income by households that live in the city. Concentrating first on the variables in the right-hand-side bracket, Y_L is labor income earned in the city, indexed by the three labor groups (subscript L), $CMIW_L$ is average income earned by workers commuting into town, CMI_L is the number of workers commuting into the city and $\vartheta_{g,L}$ is a series of taxes paid by households. The variable $CMIW_L$ enters in with a negative sign since this is labor income that flows out of town. The variable $a_{h,L}$ is a weighting matrix, and HW_h is the number working households in the city.

The second line of equation (1) is commuting out income, where $CMOW_L$ is average income earned by workers commuting out of town and CMO_L is the number of workers commuting out of the city. Since this is income flowing into the city, the value for $CMOW_L$ is positive.

The last two lines of equation (1) represent household income earned from land and capital income. Y_{LA} is household income associated with the change in residential and commercial land values and Y_k is household income due to changes in residential and commercial capital stock values. $LNFOR_{LA}$ and $KPFOR_k$ are values of land and capital income that flow out of town, as national companies own significant percentages of commercial land and capital. These two values enter in with negative signs in equation (1). As before, taxes are accounted for and appropriate weights are imposed across the household groups.

It is important to inspect the equations used to implement the simulations. Consider equation (2), which describes the equation for exports.

$$CX_i = CX0_i((PD_i*(1 + \Gamma_{GK}\ \vartheta_{gk,i}))/ (PW0_i\ (1 + \Gamma_{GK}\ \vartheta_{gk,i})))^{ETAE_i} \qquad (2)$$

The variable CX_i is the amount of exports in sector i, where i is indexed over the productive sectors presented in Table 1 and $CX0_i$ is the base value of exports (any variable with a 0 at the end of it is a base value). PD_i is the domestic price across sectors, $\vartheta_{gk,i}$ is taxes indexed over a range of taxes indexed by gk (local, state and federal taxes), $PW0_i$ is the world price for exports, and $ETAE_i$ are negative export elasticities. To execute the simulations for the manufacturing or computer manufacturing, we increase the value of $PW0_i$, which represents an increase in demand for exports. Since the two manufacturing sectors export almost all of its output, setting up the simulations in this way is consistent with structure of these sectors.[5]

Setting up the retail simulation is more complicated since a large percentage of their output is sold locally. To capture the increase in local supply, we increased the capital stock used by retail, which captures the idea that the initial change in retail is simply an increase in supply. Consider the following two equations:

$$N_{k,i} = N0_{k,i} \, (R_{k,i})/R0_{k,i})^{ETAIR_{k,i}} \, (DS_i / DS0_i)^{ETAID_{k,i}} \quad (3)$$

$$KS_{k,i} = KS0_{k,i} \, (1 - DEPR) + N_{k,i} \quad (4)$$

Equation (3) presents the solution for investment across the sectors, where $N_{k,i}$ is investment, $R_{k,i}$ is the rate of return on capital, $R0_{k,i}$ is the base value, DS_i is domestic supply across the sectors and $DS0_i$ is the base value. The elasticity values are represented by $ETAIR_{k,i}$ and $ETAID_{k,i}$. Equation (3) states that investment is a function of its rate of return as well as the level of domestic supply. The capital stock is represented in equation (4), where $KS_{k,i}$ is the capital stock across sectors, $KS0_{k,i}$ is the base value and DEPR is the depreciation rate.

To implement the retail simulation, we increase KS0 for retail, which results in an increase in the amount of retail capacity in the city. It lowers retail prices and local consumption of these goods increases. In addition, since the new retail center will also

[5] We also experimented with changing the base value $CX0_i$ for the simulations. It gave us almost identical results as compared to changing $PW0_i$ but it did cause violations of some of the identities in the model. These violations did not impact the results but we ultimately chose to alter $PW0_i$ to implement these simulations.

attract a large number of shoppers from outside the city, we also need an export dimension to the simulation. We also increased PW0 for retail since the new retail center is intended to attract shoppers from all over the region.

Executing the population simulation requires that we increase the flow of households into the community. Consider equation (5), which represents household migration:

$$HH_h = HH0_h\, NRPG_h + MI0_h(((YD_h/HH_h)/\,(YD0_h/HH0_h))/(CPI_h/CPI0_h))^{ETAYD_h}$$
$$((HN_h/HH_h)/HN0_h/HH0_h))^{ETAU_h}$$
$$-\ MO0_h(((YD0_h/HH0_h)/\,(YD_h/HH_h))/(CPI0_h/CPI_h))^{ETAYD_h} \qquad (5)$$
$$((HN0_h/HH0_h)/(HN_h/HH_h))^{ETAU_h}$$

The variable HH_h is the number of households across the six household groups, $NRPG_h$ is the natural rate of population growth, YD_h is disposable income, CPI_h is the price level faced by each household group, HN_h is the number of non-working households and $ETAU_h$ and $ETAYD_h$ are elasticities. The parameter MI0 determines how easily households migrate into the city and MO0 determines how easily households migrate out of the city. Simply stated, equation (5) says that households are attracted into the city when there is an increase in real income and move out of town when there is a decrease in real income. To implement the population led growth simulations, we alter the values of $NRPG_h$. As an example, an increase in population growth of 2% is obtained by multiplying $NRPG_h$ by 1.02.

Data

Since the data set used in this paper is fairly extensive, we have elected to only 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 the wages paid to those workers. This data is collected from two different perspectives: 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 data is collected on a town-by-town basis. In addition, every worker in the private sector has a UI number, which allows the state to track individual wages earned by individual workers for every quarter. There are several employers that are not covered by the ES-202 and UI programs, such as school districts and local, state, and federal governments. These entities must be contacted separately to obtain their wage and employment data. In addition, single proprietors must also be accounted for and added to the data set.[6]

By merging all these sources together, we can create a distribution of employment and wages by sector (Table 1), which can be evaluated under a wide range of policy scenarios. For the purposes of our analysis, we have divided workers into three groups (L_1, L_2 and L_3) as presented in Table 1. All sectors employ different percentages of the three types of workers. The distributions for computer manufacturing, manufacturing and retail play an important role in the analysis of this paper.

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[6] In the case of Colorado, the state demographer estimates the number of single proprietors. It may be the case that for other states, different state agencies may have to be contacted to obtain this information.

The standard county assessor's office keeps good records on the use of each parcel of land in the county because property taxes differ across commercial and residential properties. The imbedded abstract codes identify commercial parcels for most of the productive sectors as well as the residential housing categories provided in Table 1. Included in each parcel is data on the acreage of the parcel, market values for acreage and the market value of the structure (capital) on the parcel. The county assessor's office provides excellent data on land and capital.

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

III. Simulations

Setting up the Simulations

Since the manufacturing and computer manufacturing sectors are export driven, we increased export demand by increasing the price for exports. This was done separately for each of these sectors. The retail expansion was more complicated since we needed to simulate both an increase in supply of retail as well as effect export amounts. We increased the capital stock for retail to simulate the increase in local supply and consumption. We also increased the export price to simulate an increase in export sales. For these three simulations, the initial shock in employment is 1,000 workers per sector.[7] For the population simulation, we increased the natural rate of population growth so that

[7] The choice of 1,000 workers was chosen for two reasons. First, the projected employment for the retail Lifestyle center was approximately 1,000 employees and in addition, to compare all three scenarios, it was important to have the identical base increase in employment.

households increase by 832, which is the mid point increase in households for the manufacturing and computer manufacturing simulations.

We evaluate the simulations from both medium and long-run perspectives. The medium-run is defined as the point at which all the indirect effects have occurred. In other words, the expansions in high services, low services, construction, etc. along with population growth have all adjusted to the initial change in the economy. We estimate that this effect could take up to four years to occur. However, in the long-run, the equalization of prices and wages in the city and region will occur. We believe that this could take an additional 2-3 years. As we discussed these issues with local policymakers, they thought it important to estimate both the medium and long-run scenarios.

Table 2 presents some general characteristics of the three sectors of interest and the composition of households. Manufacturing has an annual average salary of $24,888, computer manufacturing has an average annual wage of $60,500 while retail's average annual wage is $10,178. The manufacturing sector is the largest sector of these three in terms of employment, as it employs 9.3% of the workforce. Intermediate demand is much larger for both manufacturing and computer manufacturing, which plays an important role in multiplier and price effects in the simulations.

The bottom half of Table 2 describes the general characteristics of the six household groups differentiated by income. The highest income earning household group is HH6 ($70,000 and above annually) and this group is approximately 25% of total households in the economy. Household income consists of labor, land and capital income and it is quite common that there is more than one wage earner per household. The last column of Table 2 presents the number of workers per household for each

Table 2

Characteristics of Private Sectors and Households

Sector Characteristics			
	Manufacturing	Computer Manufacturing	Retail
Employment (Percent of Total)	6,007 (9.3%)	3,784 (5.9%)	4,208 (6.6%)
Average Wages	$24,888	$60,500	$10,178
Intermediate Demand (mil of $)	804.4	847.4	50.4
Household Characteristics			
	Number	Income Earned (mil of $)	Workers per Household
HH1 < 10,000	3,491	60.1	1.1
HH2:$10,000 - 19,999	5,197	118.9	1.8
HH3:$20,000 - 39,999	8,972	311.4	1.4
HH4:$40,000 - 49,999	2,981	140.3	1.9
HH5:$50,000 - 69,999	8,595	531.9	1.7
HH6 > $70,000	10,883	1070.2	2.2
Total	40,119	2232.8	

household group. HH6 averages 2.2 workers per household while HH1 averages 1.1 workers per household. These numbers were obtained by looking at U.S. census data, information from the State Demographer's Office and estimation done by the authors. Workers per household play an important role in the interpretation of the simulations below.

Medium-Run Simulations

Table 3 presents general results for the four simulations. As expected, the expansion in computer manufacturing leads to a much greater change in Gross City Product (GCP) and several components of tax revenue. Not surprisingly, the increase in GCP is lowest for population-led growth. This is due to the fact that as new households migrate into the city, they demand goods and services from non-basic sectors and have a depressing effect on wages. The inflow of new resources is minimal and thus the impact on economic growth and tax revenue is small.

The impact on total employment and employment for selected sectors is also presented in Table 3. As before, the computer manufacturing simulation has the largest effect on employment, as its multiplier is 2.5. However, interesting differences occur when sector-by-sector effects are examined. For the manufacturing simulation, employment in retail, FIRE and lodging fall by a combined amount of 80 workers. This is the case because there are not enough new households migrating into Fort Collins, so there is a substantial competition for workers between sectors (this is explored below). Some sectors expand such as low and high services while other sectors contract. The computer manufacturing simulation causes the largest migration into the city so there is sufficient population to fuel the expansion. There are no contractions in any of the

Table 3

Economic Impact of a 1000 Employee
Expansion in Selected Sectors

	Manufacturing	Computer Manufacturing	Retail	Population
Gross City Product (mil of $)	56.4 (2.5%)	112.4 (4.9%)	35.9 (1.6%)	21.5 (0.94%)
Total Taxes (mil of $)	3.66 (4.2%)	5.93 (6.8%)	3.7 (4.3%)	1.56 (1.8%)
Sales Tax (mil of $)	1.10 (2.9%)	1.74 (4.5%)	2.81 (7.4%)	0.41 (1.1%)
Use Tax (mil of $)	1.11 (14.4%)	1.74 (22.2%)	0.31 (3.81%)	0.12 (1.5%)
Employment Impacts Selected Sectors				
Total	1,416	2,514	1,137	873
Multiplier	1.4	2.5	1.1	
Retail	-5	108	1000	61
FIRE	-46	0	-29	53
Lodging	-29	-10	-28	10
Eating	105	292	21	89
Low Services	204	364	72	94
High Services	104	343	29	128

sectors except lodging. In the retail simulation, workers are attracted away from FIRE and lodging sectors while all other sectors expand in terms of workers. The population simulation results in an increase in employment in all sectors, which is expected.

The policy implications for the above results are important. The contraction in employment in certain sectors in the manufacturing and retail simulations is an effect that the policymaker has to take into account when attracting new firms. Computer manufacturing does lead to the most balanced growth as all local sectors expand. In population-led growth, employment grows in a balanced way due to the shift outward in labor supply schedules.

Table 4 presents the impact on the number of households, land use, taxes per household, wages and prices. For manufacturing, the number of new households entering the economy is 508, for computer manufacturing it is 1,015 and for retail it is 388. We can obtain an estimate of tax revenue per new household by dividing the total increase in tax revenue from Table 3 by the number of new households. For the retail case, tax revenue per new household is $9,643, which is the highest for each of the simulations. Since the retail sector is sales tax driven, the accompanying small increase in new households results in a large tax revenue per new household amount. For the three employment-led growth scenarios, computer manufacturing has the smallest increase in tax revenue per new household. The tax revenue per new household for the population simulation is almost $4,000 less than the computer manufacturing simulation.

If the objective of the policymaker is to maximize tax revenue per household in order to increase the quality city services for police, fire, etc., then placing a priority on attracting firms in the retail sector would be advisable. From the perspective of land

Table 4

The Impact on Households, Taxes, Wages and Prices

	Manufacturing	Computer Manufacturing	Retail	Population
New Households	508	1,015	388	832
Land (Acres)	235	486	156	143
Taxes per Household	7,197	5,845	$9,643	$1,878
Wage and Price Effects				
Wage Rate 'L1'	1.36%	0.14%	1.61%	-0.40%
Wage Rate 'L2'	0.86%	0.40%	-0.04%	-0.34%
Wage Rate 'L3'	0.54%	3.66%	-0.05%	-0.43%
CPI	0.37%	0.50%	0.00%	0.01%
Number of New Workers Associated with New Households				
HH1	116	267	74	34
HH2	143	279	62	94
HH3	248	499	138	146
HH4	42	75	18	70
HH5	126	217	60	200
HH6	113	214	36	288
	787	1,551	388	832

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 annually

usage, computer manufacturing uses 486 acres to accommodate the residential and commercial expansions, while retail only uses 156 acres. From a developer's perspective, the computer manufacturing simulation would lead to the greatest growth and thus, greater profits for sectors such as construction and high services. As we have witnessed in Fort Collins, the discussion between pro-growth and moderate growth advocates can become spirited.

Another important economic impact to consider is the effect on wages and prices. In the manufacturing simulation, Table 4 indicates that wages increase the most for L1 (1.36%), less for L2 and the least for L3. This result suggests a reduction in wage inequality as lower wage groups make the largest wage gains. In the computer manufacturing case, wages increase the most for L3 (3.66%) and there is only a minimal wage increase for L2 and almost no increase for L1. This simulation results in an increase in wage inequality, as the gap between lower and higher wage groups increases. The retail simulation also witnesses a reduction in wage inequality as the lower wage groups gain relative to the higher wage groups. The population simulation does not report any meaningful change in wage distributions.

The changes in the distribution of wages across the simulations are due to the relative sizes of the increase in the demand for labor verses the new supply of workers. The increase in demand is derived from the multiplier impacts presented in Table 3. The change in the supply of workers is more complicated as there are three different sources of labor supply. The sources are workers from households migrating into the city, workers added through the change in commuting patterns and labor obtained from the conversion of non-working households to working households.

In the manufacturing case, the increase in demand for L1 workers is greater than the increase in supply of L1 workers. This can be seen from several different perspectives. As the bottom panel of Table 3 indicates, the expansion in employment (primarily L1) in low services, high services, eating, etc. is partially fueled by workers being bid away retail, lodging, FIRE as well as other sectors not presented in Table 3 (agricultural services and university). This reflects the idea that demand is outstripping supply and thus, driving up the wage for L1 workers. The exact opposite case is occurring in the computer manufacturing simulation. The only sector loosing workers is lodging, therefore, it appears there are enough new workers so that there is minimal upward pressure on wages for L1.

Of the three sources of new labor supply, it is the different pattern of in-migration of households in these two simulations that accounts for the wage differences. The employment growth for the computer manufacturing case is 1.77 times greater than manufacturing, however, the increase in households is 1.97 times greater for computer manufacturing than for manufacturing. The relatively larger increase in households for computer manufacturing manifests itself primarily in the L1 labor group. This can be seen from two different perspectives. The increase in the lower income households (HH1 and HH2) is 2.15 times greater in computer manufacturing than manufacturing. In addition, the increase in HH6 is 1.9 times greater for computer manufacturing. Since HH6 has the largest number of workers per household (Table 2) and a large number of L1 workers as second wage earners, it further increases the supply of L1 workers. Both of these effects cause the wage for L1 to remain unchanged in the computer manufacturing case as supply and demand increases offset each other. In the manufacturing case, demand for L1 workers outstrips supply and wages increase.

The effect on wages in the retail simulation is more straightforward. Since 87% 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, wages for L1 increase by 1.61% while there are negligible declines in wages for L2 and L3. The decrease in wage inequality is a desirable implication of this simulation.

The population-led expansion leads to a similar reduction in wages across the three labor groups. This is due to the way the simulation was initiated. We increased the natural rate of population growth, which maintains the same distribution of households but at a higher level. The result is that the increase in the supply of labor causes all wages to fall at approximately the same rate.

The increase in the price level (CPI) for the city is consistent with expectations across the four simulations. For manufacturing, the increase in the CPI is 0.37% and for computer manufacturing, the increase is 0.50%. This difference is largely due to the greater multiplier effect in the compute manufacturing simulation. In the retail case, there is no change in the CPI due to offsetting impacts associated with the economic growth. The increase in the export price increases demand and puts upward pressure on the CPI. However, the retail expansion is also associated with more efficient capital, which puts downward pressure on the CPI. Our estimates indicate that these effects offset each other, resulting in no change in the CPI. The population simulation has a negligible impact on the CPI.

To obtain a more complete picture on the wage inequality issue, the impact on real household income, which consists not just of wage income, but land and capital income has to be considered. As the economy expands, the private sectors require additional land and capital, which causes income from these new assets to rise, and the original Fort Collins households benefit to varying degrees. Adding together wage, land and capital income and adjusting this sum for the change in the CPI across households, Table 5 summarizes the impact on real income across the six household groups.

For the manufacturing simulation, there is a decrease in income inequality as the lower income group's benefit from a relatively large increase in real household income. In the computer manufacturing simulation, it is the case that HH1 and HH2 actually experience a fall in real income. Since their income increase is very small, the relatively large increase in the price level causes real income to fall. In this scenario, there is an increase in income inequality. In the retail simulation, there is a also a reduction in income inequality as the lower income earning household groups gain more in terms of real income. For the population simulation, all household groups are worse off in approximately the same proportions.

These results offer a wide range of information for the policymaker. If the city is considering attracting new manufacturing employers to the area, moderate wage manufacturing firms will reduce wage inequality and improve affordable housing concerns for the lower income-earning households. Retail expansion could also be a serious contender as it also reduces income inequality. In addition, retail uses the least

Table 5

Impact on the Distribution of Real Income

	Manufacturing	Computer Manufacturing	Retail	Population
HH1	0.95%	-0.04%	1.71%	-0.24%
HH2	0.55%	-0.29%	1.05%	-0.24%
HH3	0.54%	0.06%	0.70%	-0.16%
HH4	0.42%	0.09%	0.63%	-0.13%
HH5	0.48%	0.31%	0.85%	-0.14%
HH6	0.38%	0.90%	0.56%	-0.22%

amount of land (156 acres) as opposed to the computer manufacturing, which uses 486 acres. There will be smaller increases in congestion for expanding retail and larger congestion increases for expanding manufacturing.

These results also provide insights with respect to the existing literature on wage/income inequality. Considering the computer manufacturing case, the large rise in real income for HH6 offsets the fall in real income for the lower income-earning households and in the aggregate, real income rises for the entire city. At the aggregate level, there would be an increase in wage/income inequality when comparing Fort Collins with other regions not experiencing computer manufacturing driven growth, with the Fort Collins economy benefiting from the wage inequality. This would be the interpretation of Borjas and Ramey (1995), Nissan and Carter (1999 and 2001) and Levernier, Partridge and Rickman (1998) since these authors are only concerned with aggregate results for a region. However, our results reveal that even though wages are rising faster in the city in the aggregate, the wage/income inequality is actually rising within the city, as the lower income-earning households are actually worse off. This demonstrates that examining distributions within a region can reveal very different results.

As discussed above, past research has obtained both a positive and negative relationship between economic growth and wage/income inequality. The negative relationship depends upon exogenous factors such as aggregate wealth and political institutions. The positive relationship has been attributed to states where inequality is high and median income voters choose a higher tax rate, which stimulates growth (Saint-Paul and Verdier, 1993) or technological growth is substantial which leads to higher economic growth (Galor and Tsiddon, 1997). In our model, an increase in computer manufacturing caused real income for the lower-income households to decrease while real income increased for the higher-income earning households. This occurred as the economy was expanding, thus resulting in a positive relationship between economic growth and wage/income inequality. The retail and manufacturing simulations led to an inverse relationship between growth and wage/income inequality. Our results depend upon migration patterns of households where the previous literature emphasizes institutional differences.

Forbes (2000) states that a positive relationship between economic growth and wage/income inequality poses a significant tradeoff problem for the policymaker, however, she acknowledges that more evidence of this relationship is required. We maintain that our computer manufacturing result suggests this positive relationship could be widespread. Any fast growing area such as the suburbs around Seattle, Portland, Salt Lake City, Albuquerque and Santa Fe that attracts a high wage industry could lead to the same results. It is not unreasonable to expect similar migration patterns for these desirable places to live. We believe that our findings offer important support for the Forbes' result.

Sensitivity Analysis

An important issue underlying all simulations is the ease at which new households migrate into the city. It is difficult to assess this issue as there is little data to make any judgment, however, different migration patterns can have important impacts on the results. Since computer manufacturing pays the highest wage, it is reasonable to expect higher income households to migrate into town at a faster rate to benefit from higher wages. At the other end, since retail pays a relatively low wage, it is less likely that a large number of new households will enter the city.

In the simulations above, we made it relatively easy for households to migrate into the city. This was done to be consistent with the experiences in northern Colorado of high population growth. However, it is also important to understand the consequences of restricted migration patterns into the city. Therefore, we computed a large number of simulations by altering the value of MI0, the in-migration parameter from equation (5). In this way we could determine the consequences of restricted labor and household flows.

We chose to examine the sensitivity of taxes per new household to changes in migration patterns. The retail simulation was most sensitive to changes in the ease at which households could migrate into the city. In the most restrictive case, only 170 households migrate as opposed to 388 from Table 4. Tax revenue per new household increased to $20,567, which is a dramatic increase. The downside to this situation is that more workers are bid away from sectors such as construction, FIRE and lodging. What the city has to compare is the benefits of increased quality of city services to the losses incurred by the sectors that loose workers to the expanding retail sector. We feel that experimenting with different migration patterns for the retail simulation is important since it is not clear how willing households are to migrate into the area with a large number of the new jobs being low paying. For the manufacturing and computer manufacturing simulations, the restriction on migration patterns did not have large enough impacts that would cause concern among policymakers.

Long-run Impacts

All the above results describe the medium run impact where all the indirect effects have taken place. However, in a small open economy, wage rates and prices will return to external levels and these long-run impacts have to be considered as they reflect important aspects that complete the analysis. In the long run, all prices and wages equalize in the region as firms and households move into the city.

For the manufacturing, computer manufacturing and retail simulations, sufficient population has to migrate into the city so that wages for the three labor groups return to their base values. In addition, prices in the city have to also return to their base values so that there are no change relative prices in the region. This long-run perspective also supports the idea that with employment-led growth, population will follow until there is no change in relative prices or wages.

The long-run solution for the population simulation is a little more complicated as firms have to enter the region in response to the increase in population. Since we have multiple sectors in the economy, there are many choices to make in terms of which sectors should be allowed to expand in direct response to the population growth. Given that the City of Fort Collins is constantly debating whether to attract manufacturing or retail, we have chosen to expand a combination of manufacturing, computer manufacturing and retail so that there is no change in prices and wages.

The top panel of Table 6 presents the basic results for all four simulations in the long run. Computer manufacturing still leads to the greatest increase in GCP,

Table 6

Long-run Impact all Sectors

	Manufacturing	Computer Manufacturing	Retail	Population
Gross City Product (mil of $)	161.5 (7.1%)	274.8 (12.1%)	50.8 (2.2%)	88.1 (3.6%)
Total Taxes (mil of $)	6.9 (8.0%)	9.4 (10.8%)	4.9 (5.7%)	4.8 (5.5%)
Sales Tax (mil of $)	2.9 (7.5%)	4.4 (11.6%)	3.1 (8.2%)	1.5 (4.0%)
Use Tax (mil of $)	9.9 (24.7%)	2.9 (38.7%)	0.4 (5.4%)	0.85 (11.0%)
Employment Impacts Selected Sectors				
Total	4,911	7,200	2,184	2,385
Retail	291	443	1134	178
FIRE	229	387	45	93
Lodging	44	47	2	14
Eating	465	733	157	225
Low Services	571	842	206	273
High Services	566	977	169	293
Additional Impacts				
New House-holds	3,164	4,336	1,417	1,534
Land (Acres)	2,365	3,032	230	1,114
Taxes per New House-hold	$2,982	$3,491	$3,491	$3,123

employment and land use while the manufacturing simulation is still second in these effects. The interesting result is that population-led growth now has a greater impact on GCP than the retail simulation. In the population simulation, sufficient expansions in manufacturing and computer manufacturing have to occur up to the point where there is no change in wages or prices. This expansionary impact has the effect of increasing GCP enough that it surpasses the retail case. The long-run employment impacts also switch with respect to population and retail, as there is greater employment change in the population simulation.

The bottom panel of Table 6 presents results for the number of new households, acres and taxes per new household. The most interesting result is that taxes per new household even out across the four simulations. The variance across the simulations is not great enough to choose any of the four choices as a policy objective using this criterion. This occurs since there are no wage and price effects and thus, tax revenue per household has little reason to change.

In the long-run, manufacturing and computer manufacturing still use the most land. Retail-led growth uses 230 acres while the population simulation uses 1,114 acres. The explanation for the low usage of land in retail is due to the characteristics of the expansion. The long-run expansion in households for retail is 1,417 and for population-led growth it is 1,534. These increases are relatively similar but it is the distribution of new households in the two simulations that determines land usage. In the retail simulation, many lower income earning households move into town and purchase less expensive homes (HS1) or multiple unit housing (HS4), which both use less land per new household. In addition, the retail simulation allocates 70% of the new land used for residential needs while for population-led growth; residential uses only 45% of the new land. This is due to the way that the population simulation was constructed. With new employers in computer manufacturing and manufacturing moving into the area in the long-run, commercial land usage becomes a relatively larger component of total new land use. As it turns out, these effects have dramatic impacts on land usage in Fort Collins.[8]

IV. Conclusion

We have used a data intensive CGE model to estimate the medium and long-run impacts of employment-and population-led growth. Simulations were computed for economic-led growth of computer manufacturing, which is a high wage sector, a medium wage sector, manufacturing and a low wage sector, retailing. In addition, the impacts of population-led growth were also analyzed. One important impact examined was the medium run impacts on income inequality across six household groups for the original residents in Fort Collins. Since it is these residents that vote for policymakers in the city, we feel it is important to understand the economic impacts for the original residents. In the medium run, estimates indicate that retail expansion is the most efficient in terms of raising tax revenue and also reducing wage inequality in the city. Computer manufacturing-led growth increases wage inequality while manufacturing-led growth reduces wage inequality. Population-led growth has a neutral impact in the economy in terms of wage/income distribution and is very inefficient in terms of raising tax revenue.

The long-run impacts were also examined as wages and prices equalized so that there were no changes regionally in these variables. Taxes per new household equalized

[8] If we had other sectors move into the city as a response to the population-led growth, such as high services, wholesale and construction, the impact on land usage would not have been large.

across the four simulations but it was still the case that the retail simulation used the least amount of land. This is a desirable result as it conserves on undeveloped land in the city. However, what is the relevant time horizon for the policymaker? As we have discussed this issue with different local policymakers over time, they definitely believe that the gains that can be accrued in the medium run are very important. Weighing the medium and long-run results can be a difficult task.

Considering retail as a serious competitor with respect to manufacturing alternatives for emerging municipalities surrounding larger cities allows our results to be generalized for a number of regions in the U.S. We believe that examining retail, population and various types of manufacturing alternatives is relevant for any high growth region that has a relatively elastic supply of land. Cities such as Portland OR, Seattle, Salt Lake City, Denver, Albuquerque and Santa Fe all have substantial economic growth occurring outside the city limits and there is substantial competition for sales tax dollars. We believe that the issues and conclusions obtained in this paper would be similar to these regions.

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