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Estimating Costs and Benefits of Economic Growth: A CGE-Based Study of Tax Incentives in a Rapidly Growing Region

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Abstract. Municipalities have used tax incentives to attract manufacturing firms to counteract market failures, mobilize resources in blighted areas, and engage in bidding wars with other jurisdictions. These reasons have typically been remedies for regions experiencing unemployment and low growth. However, high growth areas still use tax incentives to manage growth. In these cases, the costs of growth, especially related to congestion, pollution, costs of city services and rising prices, must be compared to economic benefits resulting from a tax incentive. The case study in this paper is based on a proposal to the city of Fort Collins, Colorado by Hyundai Corporation, who requested a $25.5 million use tax rebate. This paper uses a data intensive computable general equilibrium (CGE) model to estimate endogenously the costs and benefits of growth. Results of the analysis suggest an $18.15 million rebate was warranted.

1. Introduction

Dye and Merriman (2000) provide four reasons for tax incentives: (1) if market failures are present, (2) when a blighted area exists in a city where resources are not utilized fully, (3) a city may be engaged in a bidding war with other jurisdictions to attract a firm, (4) a city may want to gain access to state tax revenues or other revenue streams, such as tax increment financing.

The first two reasons clearly relate to a government's role to clear impediments when markets do not perform optimally. Dye and Merriman are skeptical of the market failures argument, as it requires restraint by governments to keep from directing subsidies to "influential" industries. Moreover, to correct for market failures adequately, a sophisticated understanding of economic interactions is required, something governments often do not possess. In contrast, Bartik (1993) finds that directing tax incentives to blighted

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areas can efficiently employ underutilized labor and capital resources, affirming government's role in markets.

The third rationale, bidding wars, appears to have dimensions that are more complex, especially since the competing municipalities can be either high or low growth areas. In low growth areas, significant unemployment and excess capacity reduces the need to examine costs of growth because a new firm will employ idle local resources. However, in a high growth area, an expansion will require additional resources, especially an expanded labor supply, which must come from new households and changes in commuting patterns. This growth leads to greater costs, including higher prices, more congestion with attendant health problems, additional time spent commuting, and a greater need for city services. These costs and benefits need to be compared.

As a city attempts to manage a high growth economy, tax incentives still can be selectively used to attract firms to the economy. There are many households employed in sectors such as construction, retail, and services who benefit directly from a manufacturing firm entering the community. However, other households will not benefit and, indeed, could be made worse with increased congestion and higher prices. A key question is whether the net benefits, especially to the original population, are positive.

In this paper, we examine an example in Fort Collins, Colorado, a city of 110,000 people, which has seen some of the fastest growth in the rapidly growing state of Colorado. Fort Collins was approached in 1993 by Hyundai Corporation, who wished to construct a DRAM computer chip manufacturing plant that would employ about 950 workers, but only on the condition that they would receive a tax incentive of over $25 million. Pro-growth and anti-growth forces quickly formed opposing alliances, with the city council in the middle of the controversy.[2] While the council rejected the proposal, they realized that there was insufficient information to make a complete assessment. The model reported in this paper was created to address the above issues.

This research employs a computable general equilibrium (CGE) model as the primary method of analysis. The main advantage of CGEs over input-output (I-O) models is that they impose utility maximization for households and profit maximization for firms. These two assumptions result in an allocation of resources in response to changes in relative prices, which leads to differential impacts across sectors and households in the model. Indeed, tax incentives lead to changes in relative prices across sectors, so these shifts are at the heart of this type of analysis.

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[2] Pro- and anti-growth groups petition government agencies to alter incentives in their favor. Our contention is that this rent seeking behavior would be limited if clear and public estimates of net benefits to the original population were available. Rent seeking has long been studied in the trade literature as in Buchanan, Tollison and Tullock [1980].

The main objective of this paper is to estimate benefits and costs of the proposed Hyundai expansion. Hyundai's entrance into the city would have set in motion a whole series of economic effects. The economy would grow through direct and indirect business expansion, and, consequently, there would be increased employment, tax revenues and migration. Since the economy was close to full employment at the time, households needed to migrate into the city to help fuel the expansion. The increase in population would cause more traffic congestion, which would create costs that need to be reflected in the analysis. We used a separate transportation model to estimate the congestion effect and then added those costs to the CGE model. It was also necessary to model rising health costs due to increased traffic congestion.

Fundamentally, this paper takes an accounting stance with regard to the *original* residents along the lines of arguments made by Bartik (1993). Original residents vote for policymakers who make decisions to offer tax incentives, and have costs imposed on them whether they want the expansion or not. It is easy to see circumstances where a current resident experiences higher congestion and increased prices of housing or local services, but does not see wage increases because the economic sector in which they are employed is tied to an external market. A case in point would be local university employees, who might vote against policymakers who make these kinds of decisions. In contrast, new residents presumably were able to make a decision taking into account all factors. Thus, an important additional cost is the effect of rising prices relative to nominal income gains by the local population, which again is a central issue that requires a model that incorporates price reactions. A CGE model can handle these reactions while I-O models do not.

Partridge and Rickman (1998) explain that the lack of city level CGE models may be due to "the paucity of regional data." In view of this comment, a secondary objective is to demonstrate that this may not be true. Using ES202 and individual wage record data, we collected detailed data for employment and wages across numerous sectors. By utilizing county assessor's data, we also could organize land and capital values across the same sectors, which to the best of our knowledge has not been done before. We use census estimates to put labor, capital and land income into six household groups distinguished by income and, therefore, show distributional effects of changes in economic activity. A detailed data set for sales, property and use taxes was collected from the Fort Collins city government, which were allocated across productive sectors and households.

Section II describes the CGE model and section III presents the data used for the analysis. Section IV sets up the simulation, while section V presents the economic impacts of the Hyundai expansion. In section VI, the evaluation of the potential rebate is given, and section VII is the conclusion.

2. The Fort Collins CGE Model

Most regional CGE models cover relatively large geographic areas and are unable to capture the unique characteristics of a specific municipality. Examples of such studies include Seung and Kraybill (2001), who examined the impact of public investment in the Ohio economy, and Hoffmann, Robinson and Subramanian (1996), who investigated the role of defense cuts in California. Moreover, Jones and Whalley (1989) constructed a CGE model covering most of Canada, while Gillespie, McGregor, Swales and Yin (2001) constructed a model for Scotland to examine the impact of the Regional Selective Assistance program in that country. In our case, a city-level CGE model is necessary because many tax jurisdictions are based on city boundaries and regional CGE models are unable to capture the uniqueness of a particular city.[3]

There have been only a limited number of attempts at modeling smaller geographical regions. Seung, Harris, Englin and Netusil (1999) constructed a CGE model for Churchill County, Nevada to assess the impact of reallocating surface water from irrigated agriculture to recreational use. Also, Taylor and Adelman (1996) noted that large CGE models do not capture the unique characteristics of local towns and, therefore, constructed small village CGE models for towns in West Africa and Mexico.

The Fort Collins CGE model presented in this paper is motivated by the need to capture unique characteristics of the study area, as expressed in Taylor and Adelman (1996). Table 1 presents a summary of the structure our model. There are 17 productive sectors that utilize profit-maximizing combinations of labor, capital and land. Each sector produces a composite commodity, which is sold as domestic supply or exports according to a constant elasticity of transformation (CET) function. Producers are assumed to maximize profits subject to a specific production technology, which is represented by a two-stage production function. Intermediate inputs are used according to a fixed-proportions, Leontief production function, while primary factors are combined using a Cobb-Douglas production function. Following Armington (1969), intermediate demand is satisfied from either imported or domestic goods.

Consumers are divided into six household groups based on income. The representative consumer maximizes a utility function subject to a budget constraint, which equals the income from primary factors less taxes, but with private and governmental transfers added. This income is allocated to in-

[3] Schwarm and Cutler (2003) demonstrate that for Windsor, CO (population 5,000), Loveland, CO (population of 50,000) and Fort Collins, CO (population of 100,000), the impact of the same firm moving into either town will result in very different solutions in terms of commuting, inmigration of new households and zoning for new residential homes. These differences are due to differential wage structures in the three municipalities.

vestment (savings), private consumption, and expenditures on housing and net transfers to the outside economy. Utility maximization is achieved using a constant elasticity of substitution (CES) function, and households purchase optimal quantities of the composite private goods, treating local and imported commodities as imperfect substitutes. Households purchase four housing services that vary by price; moreover, they are nontraded goods.

Table 1. Dimensions of the Fort Collins CGE Model

Profit Maximizing Sectors		
1) Agricultural Services	10) Transportation and utilities	
2) Agricultural production	11) Communications	
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) Forestry and Fisheries	
7) Manufacturing	16) Universities and Junior Colleges	
8) Mining	17) School District	
9) Computer Manufacturing		
Housing Market (Price Range)	**Household Groups (Annual Income)**	
HS1: <$120,000	HH1: <$10,000	
HS2: $120,001 to $199,999	HH2: $10,001 to $19,999	
HS3: ≥$200,000	HH3: $20,000 to $39,999	
HS4: Multiple Units	HH4: $40,000 to $49,999	
	HH5: $50,000 to $59,999	
	HH6: $60,000 to $69,999	
	HH7: >$70,000	
Labor Government Services	**Taxes**	
1) Fire	1) Sales	
2) Libraries	2) Use	
3) Parks and Recreation	3) Property	
4) Police	4) Other	
5) Transportation		
6) Administration		
Factors of Production		
Labor Groups	**Capital Stock***	**Land***
L – labor	K – buildings and factories	Land – land used

*In productive, residential and public activities. Units for Capital stock is dollars, and Land measured in acres.

The government is modeled at two levels to reflect state/federal and local institutions. The state and federal component collects income and social security taxes. The local government generates revenue from property, sales, use and other taxes, in addition to receiving lump sum payments from federal and state sources. The revenues are used for expenditures in five local government sectors (Police, Transportation, Fire, Parks and Recreation, and

Administration). These sectors hire labor, and purchase inputs and services from the productive sectors, but they do not maximize profits. The local government is, however, required to have a balanced budget.

Four equations merit closer attention as they figure prominently in our simulation results. The first equation of importance determines the total number of households in the city, and is, in effect, a migration function:

$$a_h = \bar{a}_h \cdot \pi_h + \bar{a}_h^{in}\left(\frac{y_h^d}{a_h} \div \frac{\bar{y}_h^d}{\bar{a}_h} \div \frac{p_h}{\bar{p}_h}\right)^{\eta_h^{yd}} \left(\frac{a_h^n}{a_h} \div \frac{\bar{a}_h^n}{\bar{a}_h}\right)^{\eta_h^u}$$

$$- \bar{a}_h^{out}\left(\frac{\bar{y}_h^d}{\bar{a}_h} \div \frac{y_h^d}{a_h} \div \frac{\bar{p}_h}{p_h}\right)^{\eta_h^{yd}} \left(\frac{\bar{a}_h^n}{\bar{a}_h} \div \frac{a_h^n}{a_h}\right)^{\eta_h^u} \qquad \forall h \in H \qquad (1)$$

The number of simulated households within each income group (a_h) is a function of existing households ($\bar{a}_h$), which is multiplied by the natural rate of household growth, π_h, and by two terms that determine net migration into town. The rate of in-migration is captured by the term starting with $\bar{a}_h^{in}$. Households migrate out of town based on the term starting with $\bar{a}_h^{out}$. Both of these factors depend on real household after-tax incomes ($y_h^d / a_h^w / p_h$) and a household group's fraction of nonworking members (a_h^n). Total population is thus a function of the changing attractiveness of Fort Collins as measured by real after-tax earnings changes and employment prospects.[4]

$$\frac{a_h^w}{a_h} = \frac{\bar{a}_h^w}{\bar{a}_h}\left(\left(\frac{\sum_L \left(\frac{r_L^a}{\bar{r}_L^a}\right)}{\left(\frac{p_h}{\bar{p}_h}\right)}\right)\left(\frac{\sum_{Z,L} u_{z,l}^d}{\left(\sum_H a_h^w * \varepsilon_h\right) + CMI}\right) + \left(\sum_L \frac{Exwage^L}{r_L^a}\right)\left(\frac{CMO}{\left(\sum_H a_h^w * \varepsilon_h\right) + CMI}\right)\right)^{\eta_h^{LS}} \left(\frac{\sum_{g \in G} \frac{w_{h'g}}{p_h}}{\sum_{g \in G} \frac{\bar{w}_{h'g}}{\bar{p}_h}}\right)^{\eta_h^w} \qquad (2)$$

$$\forall\, h \in H$$

Labor supply is presented in equation (2). It is expressed in terms of the household participation rate, which is the number of working households (a_h^w) divided by the total households in an income class (a_h). This is a function of the initial participation rate ($\bar{a}_h^w / \bar{a}_h$), adjusted by several factors

[4] The specification for equation (1) is motivated by Greenwood (1975) and Greenwood et. al. (1991). It was shown that migration is driven by costs specific to the location, expected future earnings, information costs and personal characteristics. We include real disposable income to represent location costs and expected income.

that shift during a simulation. The first factor is a variable economy-wide wage rate (r_L^a), which is deflated by the consumer price level for each household group (p_h) and is calculated relative to the base values of wages and prices ($\bar{r}_L^a$ and $\bar{p}_h$). It is weighted by the proportion of labor demanded in the city ($u_{z,l}^d$) relative to total supply of labor, which is $\left(\sum_H a_h^w * \varepsilon h\right) + CMI$. The first term in this latter expression is the number of laborers from Fort Collins households, derived from the working households in each group times ε_h, the number of workers per household group. CMI is the number of workers who commute into Fort Collins.

Similarly, the external wage, $Exwge_L$, is compared to the local wage rate (r_L^a) by weighting that factor by the proportion of Fort Collins residents who commute out of town to work, CMO, again relative to the total supply of labor. Thus, households in Fort Collins decide whether to work in or out of town based on a weighted average of the relative wage rates inside versus outside the city. The last factor is the household's average transfer payments when not working ($w_{h'g}$), which again is deflated by household-specific price indexes and calculated relative to base levels. Each household responds to changes in these factors according to specific elasticities (η_h^{Ld}, η_h^W). High-income households have higher elasticities with respect to wages and taxes than do low-income households, but high-income households are assumed not to respond to transfer payments. Low-income households have lower elasticities with respect to wages and taxes but higher responsiveness to transfer payments.

Finally, the commuting equations are specified as follows:

$$CMO = CMO_O * \left(\frac{Exwage_L}{r_L^a}\right)^{\eta_{co}^L} \quad (3)$$

$$CMI = CMI_O * \left(\frac{r_L^a}{Exwage_L}\right)^{\eta_{co}^L}. \quad (4)$$

These equations specify, first, the behavior of those inhabitants who commute outside the city to work and, then, those who come into Fort Collins as workers. In Equation (3), CMO_o is the base number of workers commuting out of Fort Collins. This base value is adjusted as $Exwage_L$, the external wage rate, varies relative to the internal return to labor (r_L^a). Commuting into the city is set up in a similar fashion in equation (4). The response of commuters is also influenced by the elasticities η_{co}^{L} and η_{ci}^{L}. Thus, changes in commuting are a result of the attractiveness working in town versus outside and the sensitivity of the workforce to those changes.

Commuting has an important affect on the benefits and costs of the Hyundai expansion. If a shock to the economy causes only a small change in commuting patterns, more households must migrate into the city, with consequent impacts on congestion and pollution. However, if many workers originally commuting out decide to seek employment within the city, then fewer new households are required. The consequences would be a smaller increase in congestion, lower costs of economic growth and a smaller increase in the demand for new city services. On the other hand, with fewer households entering the city, there will be smaller multipliers and less overall economic growth.

3. Data Requirements

The major sources of data include ES-202 and unemployment insurance (UI) data, county assessor's data, the Fort Collins Consolidated Annual Fiscal Report, the U.S. Census, IMPLAN, and household expenditure distributions from the BLS Consumer Expenditure Survey. These sources of data are used to develop a refined social accounting matrix that is the basis for the CGE model used here.

The Colorado Department of Labor collects data on the number of workers in each sector and their wages using ES-202 and UI databases. ES-202 data provides quarterly reports from firms about workers employed and the total wage bill paid. Theoretically, every private employer is required to supply this information 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 for every quarter. Combining the ES-202 and UI data, we created a distribution of employment and wages for the CGE model. (Some manipulations are required to incorporate this data. For example, sole proprietors have to be included and full-time equivalents [FTEs] determined from records that do not contain the time worked, but only the wage bill).

The Larimer County Assessor's Office keeps records on the use of each parcel of land because property tax rates differ across commercial and residential properties. Abstract codes identify the use of a parcel by putting it into a category such as retail, manufacturing, services, etc. Data on acreage and its market value as well as the value of the structure (capital) are included for each parcel. Therefore, adequate data can be obtained for land and fixed capital for each of the profit maximizing sectors. The values for personal property are less reliable in these databases, so we adjusted the total value of capital using comparisons with ratios in IMPLAN. Similar data are also available for residential properties. For assessment purposes, the county collects data on market values of acreage and housing on each parcel, which was used to compute housing expenditures for our six household groups. As Table 1 indicates, homes are divided into four categories: houses less than $100,000 (HS1); houses between $100,000 and $199,999 (HS2); houses valued at $200,000 and above (HS3); and multiple units such as apartments and condominiums (HS4).

Households are divided into six groups based on the income they receive from the labor, land and capital flows discussed above. Additionally, outside remittances to households, such as private retirement or welfare payments, are included. The portions coming from the three sources of income were adjusted to reflect those for Larimer County found in the Regional Economic Accounts data of the Bureau of Economic Analysis (found at http://www.bea.doc.gov/bea/regional/data.htm).

Using 1990 census data and the Colorado state demographer's estimates on the distribution of household income, we were able to attribute these sources of income to the household groups.[5] We started with eight labor groups and mapped them into the six household groups relying on census estimates and inferences from the state demographer. For the purposes of the CGE analysis, we aggregated the eight labor groups into one labor group as shown in Table 1. The calculation of household purchases from the various economic sectors came from a combination of IMPLAN coefficients and the BLS Consumer Expenditure Survey.

The data taken from the Fort Collins government included employment and wages, non-labor expenditures for city services, and tax collections. We divided the city into five categories, to permit expenditures on police, fire, transportation, city administration, and library, parks and recreation. In some cases, there are transfers from the city to related entities, such as the school district or Larimer County government. These transfers are treated either as a purchase of services, as for schools, or are transferred out of the city and are not considered further, as in the case of funds going to the county.

The Fort Collins Consolidated Annual Fiscal Report was used to identify the taxes collected by the city. These revenues include sales, property and use taxes, along with impact fees and other taxes. The tax payments are distributed across firms and households based on data from the City of Fort Collins Finance Department. Moreover, we collected employment and wage data, as well as non-labor expenditures, for the Poudre School District.

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[5] Jim Weskott, the state Demographer for Colorado, was very helpful in supplying data and interpreting a wide range of data issues.

4. Setting up the Simulation: Reflecting Hyundai's Entrance into Fort Collins and Accounting for Costs of Growth

In this section, the base data supplied by Hyundai is first reviewed as it is used as a benchmark for the simulations. We then summarize how the simulation is implemented. The last part of this section discusses the identification of the economic costs including price changes, increased congestion, health costs and the costs of maintaining adequate city services. All of these costs are reflected in the CGE model so that the relative importance of each factor can be ascertained.

The Hyundai Proposal

Hyundai supplied basic information describing the inputs required to set up the manufacturing plant, which appears in Table 2. The corporation intended to purchase 150 acres, build a $30 million factory, and import over $1.5 billion of equipment. The local business-financed development corporation, Fort Collins Inc., calculated the anticipated taxes based on the city's tax structure. They concluded that Hyundai would pay $55.1 million in taxes to the school district over five years. At the time of the proposal, the school district had sufficient capacity to handle the expected increase in students and was willing to give the maximum legal rebate of 50 percent. The use tax on machinery and construction equipment was to be $29.8 million over five years. (Other taxes beyond the use tax on machinery were justified and were not under discussion for rebate). Hyundai requested a $25.5 million tax rebate, so our objective was to determine what portion of the rebate could be economically justified.

To implement the Hyundai expansion, we expanded exports for the manufacturing sector until an additional 950 workers were employed in manufacturing.[6] This was done by increasing the external price for exports in the manufacturing sector, which resulted in an increased demand for workers, in-migration of households, changes in commuting patterns and a general rise in economic activity.

However, it was also necessary to reflect costs of economic growth within the simulation, which was accomplished using a two-step procedure.

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[6] We do not capture two aspects of the expansion. The construction phase of the project is not included because effects would be temporary and most revenues would go to externally-owned construction firms. Secondly, the total capital stock increase amounts to doubling the capital in Fort Collins. However, the impact of the Hyundai capital is not as large as it might appear, as that capital income flows out of town. In addition, because the use tax collection is a one-time event, putting it in the model implies that it is a continuing flow and therefore, is not correct. As such, we just let capital expand as it would in normal manufacturing growth, and we recognize that part of the use tax collected is in the simulation and part is not.

The simulation described above was used to obtain an initial estimate of new households, which resulted in rising traffic congestion in the city. We then used a transportation model (MINUTP) to estimate the increase in congestion, in terms of additional vehicle miles traveled (VMT) and vehicle hours traveled (VHT). These costs, along with the health costs from additional vehicle pollution, were imposed on the CGE model and a second simulation was computed. Since the simulation already reflected the costs associated with price changes and city services, we are able to account for all major costs of economic growth endogenously.

Table 2. Key Elements of the Hyundai Proposal

Physical and Investment Characteristics	
Land Requirements	150 Acres
Building	$30 Million
Equipment	$1.58 Billion
Employment Type and No. of Workers[a]	
Engineers	100
Technicians/Maintenance	200
Administration	50
Operators	600
Total	950
Taxes to be Paid (Gross Value for Five Years)	
Construction Use Tax	$1.3 million
Manufacturing Use Tax	$25.5 million
Other Use Tax	$3.0 million
Poudre School District Tax	$55.1 million

[a] The average wage is $30,000 plus benefits.

Congestion and Health Costs

The MINUTP model utilizes four main types of data to determine travel distances and times in the city: the street network of Fort Collins and surrounding areas; the number of traffic lanes and posted speed limits; the number of cars on various roads in the city; and, the location of the retail and non-retail jobs and population residences. MINUTP is a gravity model so that, as one road becomes too congested, an alternative route is used and travel times increase.

We use the VMT to estimate the impact of increased pollution levels on health costs. As VMT increase, carbon monoxide, hydrocarbons, particulate matter and nitrogen oxide will increase. Small and Kazami (1995) examined the health costs associated with automobile emissions in Los Angeles for the early 1990s. Looking at mortality rates, morbidity rates and health costs, they determined that costs were three cents per mile. Given the density of population in Los Angeles compared to Fort Collins, we would expect this number to be lower in Fort Collins, but given the higher altitude and thinner air, this might not necessarily be true. Thus, we left the value at three cents per mile. Due to the expansion, the additional annual VMT is 24.7 million miles. To compute health costs, we multiply these miles by $0.03 and distribute them over each household group based on its population.

The MINUTP model estimated that the average household would spend an additional 4.6 hours a year in their car because of increased congestion. A wide range of estimates regarding the opportunity cost of time from congestion is found in the literature. Small (1992) estimates that the opportunity cost of sitting in traffic is 50% of the gross hourly salary of an individual. In a second study, Calfee and Winston (1998) estimate opportunity costs of $3 an hour for low-income groups and $7 an hour for high-income groups. Thirdly, Calfee, Winston and Stempski (2001) use a qualitative dependent variable approach and willingness to pay estimates to reveal opportunity costs of time in the range of 14% to 27% of average hourly salary. Also, as we proceeded with this study, the Fort Collins City Council thought that using $10 per hour for each person would be an appropriate yet conservative estimate of the cost of time. Because our analysis was centered on households, we transformed these congestion costs from workers to households.

We computed the impact of the different opportunity costs of time and found that the differences were very minor. A flat rate of $10 an hour did not lead to very different outcomes than did 50% of gross salary. This occurs because, for lower income households, $10 an hour was greater than 50% of gross salary while in upper income households, $10 is less. The opposing effects offset each other. Even with the lower $3 and $7 estimates, the differences were not large. Therefore, we used the $10 per hour value.

Incorporating Costs of Growth in the Fort Collins CGE model

In the second round of simulations, we imposed congestion and health costs using estimates discussed above. First, a penalty was put on the production function across sectors so that congestion costs would cause a reduction in production. The penalty reduced productivity on average by 0.01% for each sector, which corresponded to the increase in travel time measured by VHT. The congestion also increased the cost to consumers of making purchases in town, so we placed a penalty on the first order conditions of the expenditure functions for households. The last cost was the direct impact of a loss in leisure due to increased congestion. We multiplied the increase in time per household of sitting in traffic, which is 4.6 hours annually, by the opportunity cost of time of $10 per hour discussed above. We subtracted these amounts from each household's remittances from outside Fort Collins as a way to exogenously reduce available income and, thus, fully account for the costs of economic growth. The other two costs of growth, the change in the city price level and the increased demand for city services, are already taken into account in the model.

5. General Economic Effects from Hyundai's Entrance into Fort Collins

The first part of this section summarizes effects of the Hyundai expansion on economic output and taxes, and then we assess the sources of new employment.

Overall Effects

The overall impacts of the Hyundai expansion are presented in Table 3. Direct and indirect impacts of the expansion cause Gross City Product (GCP) to increase by $67.7 million, a 2.97% growth rate. Secondly, the 950-employee expansion leads to a total increase of 1,878 workers, yielding an employment multiplier of 1.98. The growth in employment, excluding manufacturing, comes mainly in the construction, restaurant, retail, and low and high services sectors. As relative prices increase in these sectors, workers are drawn out of agricultural processing, FIRE and lodging, which do not experience significant gains in demand from Hyundai's expansion. Lodging and agricultural processing lose employees because they rely on exports, which do not increase, while at the same time they can obtain higher wage rates in the growing sectors. Employment in FIRE contracts because of its dependence on imports; sectors with large portions of imports can substitute that source of output easily for local production. FIRE thus provides an important source of labor for the expanding sectors.

Tax revenue from all sources rises by $2.54 million, a 2.91% increase. The increase in use tax revenue comes only from multiplier effects, while the direct use tax revenue associated with the Hyundai expansion is excluded. The number of new households (presented below) is 750, a 1.87% increase. This percentage gain is less than the tax revenue growth, so the city can supply more police, fire, parks and recreation per household. From this perspective, the original residents would appear to benefit.

However, in any city that is growing, there are always additional capital expenditures needed, such as street widening, new streets and improved traffic light systems. The presence of Hyundai just makes these expenditures needed more quickly; they probably are not greater, just earlier. Thus, some opportunity cost of capital needs to be included because the Hyundai expansion will cause the city to move closer to a date when these projects should be undertaken. Depending on the size of these expenditures, the costs could be considerable. If $20 million in capital expenditures is moved up by just one year, the costs could easily be $1.0 million at a 5% cost of funds. This estimate will be included as a cost in our cost/benefit analysis.

Table 3. The Simulated Impacts of Hyundai's Entry into Fort Collins

Changes in:	Base Values	Change	Percentage Change
GCP ($ mil)	2,331.7	67.7	2.97%
Employment	64,281	1878	2.92%
Employment by Sector			
Manufacturing	9,791	950	9.7%
Construction	5,685	194	3.4%
Agric Processing	1,021	-1	-0.1%
Retail	4,208	51	1.2%
FIRE	2,078	-19	-0.9%
Lodging	855	-15	-1.8%
Restaurants	6,309	169	2.7%
Low Services	7,149	247	3.5%
High Services	8,459	151	1.8%
University	6,397	9	0.1%
Tax Revenues ($ mil)			
Property	8.08	0.41	5.04%
Sales	38.20	1.20	3.15%
Use	7.70	0.17	2.26%
Other	33.40	0.76	2.27%
Total	87.38	2.54	2.91%

Sources of labor for the Hyundai expansion

The increased demand for labor can be met from two sources of supply (equations [1] to [4]). The major source is new households migrating into town in a manner consistent with equation (1). In addition, commuting patterns can change, with fewer workers commuting out of Fort Collins and more workers commuting into town. These patterns were identified to be a function of the external versus internal wages rates, as presented in equations (3) and (4).

First, consider the primary source of labor from new households migrating into the economy. Table 4 reports that 750 new households enter the city and account for 1,297 of the 1,878 new jobs in town. The model requires that we have a parameter that transforms households into workers, which is based on the numbers of workers per household group from the BLS Consumer Expenditure Survey. The numbers ranged from 1.1 workers for HH1 up to 2.1 workers for HH6. New households thus account for 69% of the additional 1,878 new jobs.[7]

[7] One critical implication is the requirement for low and moderate wage employees to fuel the expansion. The CGE model takes housing price increases into account and, thus, raises costs of essential expenditures by households and potentially limits in-migrants. Numerous observers of growth in Fort Collins have mentioned affordable housing as a main issue in Northern Colorado, and this expansion clearly puts on further pressure in this area. Indeed, the ability of the economy to provide benefits here hinges crucially on these wage earners being able to move into the region in sufficient numbers.

The second component of labor supply comes from changes in commuting patterns. With an increased number of local jobs, workers originally commuting out of town are attracted to the increased employment opportunities internally. Initially, 14,647 workers commuted out of town, but the Hyundai expansion reduces that value by 560 workers. In addition, we estimate that 21 additional workers will commute into town.

Table 4. New Households Entering Fort Collins, by Income Category from Hyundai's Entry into Fort Collins

	Base Values	Change	Percent Changes	Number of New Workers
HH1	3,491	55	1.58%	61
HH2	5,197	94	1.81%	172
HH3	8,972	177	1.97%	253
HH4	2,981	57	1.91%	99
HH5	8,595	160	1.86%	273
HH6	10,883	207	1.90%	440
Total	40,119	750	1.87%	1,297

The 560 local workers who no longer commute out of town receive 31.0% of new jobs. This estimate is larger than Bartik's (1993) conclusion based on time series data for many SMSAs that 25% of new jobs go to original residents, but it is approximately the same magnitude.

6. Costs and Benefits to Local Residents

In this section, we compare the economic benefits to the original households from additional labor, land and capital income earned to the costs of that growth and determine whether a tax rebate is justified.

Income for the household groups comes from labor, land and capital sources. With respect to labor income, the economy-wide wage rate (r_L^a in equation [1]) rises by seven-tenths of one percent, although this increase only impacts certain labor groups. The 560 workers who no longer commute out of town benefit by this wage increase, as the external wage is assumed not to change. We hypothesize that, in addition to the expansion of the manufacturing sector, the construction, retail, restaurants, and low and high services sectors see this average wage growth because they are mostly dependent on local demand for growth. There is less reason to expect that secondary school, university, public utilities and other export sector employees will receive higher salaries in the simulation. Thus, we assume in the following calculations that only 71.0% of original workers benefited from the higher wages, those in the local sectors listed above.

The two other sources of household income are from land and capital. As the economy expands, businesses and households require additional land and capital, which causes income from the increased level of assets to rise, and original Fort Collins households benefit to varying degrees. Additionally, increased returns to these assets occur as demand increases. Part of this increase comes from housing because, as new households migrate into town, housing prices rise and original residents see greater income and wealth from these assets. As the price of houses increases, the returns (and income) of the local residents are affected positively, depending on their ownership of homes. The costs *and* benefits of rising housing prices are both included in the simulation. Homeowners receive more capital income from greater home values, but they face higher prices on the expenditure side if they choose to buy more housing.

The total increase in nominal income for the six household groups appears in the first data column of Table 5. Of the $4.059 million increase, labor income contributes $2.79 million, capital income contributes $1.06 million, while land income accounts for $209,000. These proportions naturally vary by income, with HH1 having almost an exclusive dependence on labor income while over a quarter of the nominal income gains for HH6 is from land and capital income. The highest percentage gains in household income are for the lowest income-earning households (HH1, HH2 and HH3). This is the case because most indirect effects are found in the retail and low services sectors, which pay the lowest wages and therefore affect lower-income household groups more. The reason that HH6 is not affected as much as might be expected is that many HH6 families are employed at Colorado State University, and those wages do not vary much.

The model has different consumer price indices (CPI) for each household group because expenditure patterns differ across income levels. The estimates of nominal income are in the first two data columns of Table 5. These values are deflated by these household-specific CPI values to determine the change in real income per household. The third and fourth data columns in Table 5 report these results. The only household that experiences positive real income growth is HH1, which sees gains of $120,000, while the loss for HH6 is $1.283 million. For original households in total, there is an annual $1.833 million loss. This is not surprising because, in the base year used, the economy was at full employment, so growth led to rising prices. In addition, we have assumed that wages do not change in most export sectors and, thus, price changes overwhelm nominal income changes for most household groups.

Table 5. Comparison of Economic Benefits and Costs to Original Households from Hyundai's Entrance to Fort Collins

	Change in Nominal Income (mil of $)	Percentage Change in Nominal Income	Change in Real Income (mil of $)	Percentage Change in Real Income	Change in Real Income (mil of $) No Costs	Percentage of Change in Real Income No Costs
HH1	0.222	0.54%	0.120	0.90%	0.158	1.18%
HH2	0.381	0.49%	-0.140	-0.15%	-0.111	-0.12%
HH3	0.870	0.41%	-0.133	-0.08%	-0.041	-0.02%
HH4	0.303	0.27%	-0.111	-0.15%	-0.090	-0.12%
HH5	0.912	0.26%	-0.286	-0.14%	-0.200	-0.10%
HH6	1.379	0.26%	-1.283	-0.27%	-1.119	-0.24%
Total	4.059		-1.83		-1.40	

The last two columns of Table 5 report the real income changes without congestion and health costs associated with the expansion. This was estimated through a separate simulation that did not have these costs in the model. The results indicate that the economic loss due to these factors would have been $430,000, as real income falls by only $1.4 million instead of $1.83 million.

The final objective is to compare the costs and benefits of the Hyundai expansion and evaluate the size of the tax rebate due Hyundai. Table 6 reports these results. Since the Hyundai plant will be fully depreciated over six years, we made the comparison after converting all values to six-year present values using a three percent discount rate.
The economic losses due to the expansion are divided into three components. The loss of real household income from price effects is $5.66 million, while losses due to congestion are $1.85 million over the six-year period. The third loss is due to the acceleration of the construction costs for road improvements and other infrastructure, which might be roughly $1.0 million. The economic gain due to the expansion occurs since tax revenue increases at a faster rate than the growth in households. Tax revenue increased by 2.91%; the number of households grew by 1.87%; the difference of 1.04% is the net gain in the ability of the city to provide public services. This accrues to $1.15 million dollars over the six-year period. Subtracting the economic losses from the requested $25.5 million dollar rebate and adding the economic gain from tax revenue yields a tax rebate of $18.15 million. Thus, in an extended analysis, Hyundai was due a rebate on a significant portion of the manufacturer's use tax. However, as we note below, this is a unique situation and other assumptions, or simulations of different types of firms may well lead to different outcomes.

Table 6. Hyundai's Estimated Tax Rebate

Variable	Value in Millions of Dolars
Requested Tax Rebate	25.5
Economic Costs[1]	
Real Income of Original Households	5.66
Congestion Costs	1.85
Infrastructure Finance Costs	1.0
Economic Gains[1]	
Tax Revenue Per Household	1.15
Net Tax Rebate Due	18.15

[1] These costs and gains are net present values for six years of flow values taken from the Fort Collins CGE model.

7. Conclusion

This paper presents a method of evaluating costs and benefits of economic growth endogenously in a CGE model. Based on more comprehensive data and using a more disaggregated approach than is typical, we estimated the economic benefits to the original residents of Fort Collins, Colorado from Hyundai Corporation bringing a 950-employee manufacturing firm into the city. In addition, we imposed the costs of economic growth -- increased congestion and health costs related to pollution -- on the CGE model. Hyundai asked for a $25.5 million tax rebate as a condition of locating the firm in Fort Collins. By evaluating costs and benefits, using an accounting stance aimed at identifying effects on *original* residents, we estimate that the maximum rebate should be $18.15 million. Moreover, the city should find mechanisms to compensate local residents for the costs they bear.

These results are influenced by the economy of Fort Collins during the time analyzed. This area of northern Colorado has been quickly growing, with very little excess capacity, so a substantial increase in local prices is logical as resource constraints are reached. Modeling a town that was economically depressed, as suggested in the introduction, would require introducing slack equations into the CGE model. The consequence would be that prices would not rise very much and real income effects would be greater. This would very likely lead to different conclusions regarding the size of the tax rebate to Hyundai.

These results also depend on whether households will actually migrate into the city as a response to the Hyundai expansion. We assumed that sufficient households enter the city in response to the direct and indirect effects. Another important assumption is the change in commuting patterns. If commuting out does not decline much in a simulation, it leads to more new households and congestion. This would increase costs faster than benefits, but the city officials felt it was reasonable to use the commuting patterns that we assumed here.

The existence of a manufacturing use tax in Fort Collins, in combination with the vast capital stock additions proposed by Hyundai, equivalent to nearly the entire capital stock of the city, means these simulations probably represent upper limits on the capital-labor ratios of incoming manufacturing firms. Most other projects would have more labor demand relative to use tax payments, and so would likely generate more congestion and less tax revenue than in this case. It would therefore be less likely to be a benefit to the city's original residents.

A final comment is in regard to the efficacy of using CGE models on a routine basis for policy analysis. In this setting, given the city tax structure and centrality of capital-labor ratios, it is possible to simulate a range of likely benefits and costs for different capital-labor ratios. These could provide rules of thumb for policymakers, thereby reducing the need for a constant interaction between government officials and model builders. Also, the initial development and understanding of CGE models can be quite time consuming. But with developed models, and knowledge of data sources, rebuilding and extending our modeling framework has become a moderate, rather than onerous, exercise.

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