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Does congestion negatively affect income growth and employment growth? Empirical evidence from US metropolitan regions

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ABSTRACT

Traffic congestion has long been among the biggest economic problems in US metropolitan areas. Scholars have argued the importance of research focusing on transportation planning that aims to mitigate traffic congestion and reduce economic costs. However, most existing work has overlooked the interrelationship between congestion and economic components. With this perspective, this study seeks to explore the interrelationship between congestion, income, and employment. To this end, we focus on 86 US metropolitan areas by utilizing a simultaneous equation model. The results show that there is an interrelationship between income growth, employment growth, and congestion growth, but their effects are somewhat different between periods of the economic boom in the 1990s and the economic recession in the 2000s. In addition, our findings clearly show that traffic congestion growth negatively affects income growth and employment growth. It is suggested that transportation policy that aims to reduce traffic congestion could provide economic benefits in terms of increasing employment growth as well as income growth.

1. Introduction

Traffic congestion has long been considered one of the biggest economic problems in United States (US) metropolitan areas. Transportation planners and engineers have made a great effort to provide an efficient urban transportation system, but road capacity and transport networks could not keep pace with rapid urbanization and growing demand for transportation. According to the Texas Transportation Institute, traffic congestion will increase continuously if this urban growth pattern persists (Schrank, et al., 2012). It has been argued that research focusing on transportation planning that aims to mitigate traffic congestion and reduce economic costs is important. However, scholars have also argued that an understanding of the interplay between people and jobs that generates travel demand is essential because the congestion level is determined by the location preferences of households and firms in an urban area (Wheaton, 1998; Downs, 1992).

Urban economists have argued that firms are gathered in the center of cities because they want to enjoy economic benefits of agglomeration[1] (Rosenthal and Strange, 2004). And households disperse around the center of the city. That is, urban spatial structure is determined by interactions between economic activities from firms and households. And in the middle of this process, traffic congestion naturally occurs and its level can increase or decrease. In order to ameliorate increasing congestion in large metropolitan areas, expansion of road capacity, congestion pricing, and other strategies have all been used. However, previous studies revealed that these policies are not a panacea in resolving traffic congestion (Boarnet, 1997), and suggested that more in-depth understanding of the relationship between congestion and economic factors is required (Cervero and Hansen, 2002).

Apparently, severe traffic congestion in urban areas could decrease economic growth. Sweet (2014) and Hymel (2009) empirically showed that traffic congestion has a negative effect on job growth in US metropolitan areas. At the same time, decline in job growth may affect wages or household income because job growth and income growth are closely connected to each other (Gebremariam, et al., 2010; Greenwood and Hunt, 1984). Hence, as severe traffic congestion continuously diminishes job growth, it can also negatively affect workers' wages and household income. In other words, traffic congestion has negative effects on employment growth as well as household income growth, and simultaneously growing jobs and income also increase traffic congestion. However, most existing research has overlooked the interrelationship between congestion and economic components.

Taking this perspective, this study seeks to explore the interrela-

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[1] According to the agglomeration economics, firms are gathered because they need for face-to-face contacts (Charlot and Duranton, 2004), technological externalities (Fujita and Ogawa, 1982; Henderson; 1974), production externalities (Lucas and Rossi-Hansber, 2002), and reduction of costs of moving goods over space (Krugman, 1991).

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tionship between congestion, income, and employment. Specifically, the purpose of this study is to address two questions that are pertinent to the issue of the interrelationship between congestion growth, employment growth, and income growth. First, we focus on the how congestion growth affects income growth and employment growth. Second, we investigate the opposite case, namely, how income growth and employment growth affect congestion growth. To this end, we evaluate 86 US metropolitan areas by utilizing a simultaneous equation model. This study is expected to contribute important empirical evidence to obtain a better understanding of the interaction between traffic congestion, employment, and income in an urban area.

The next section presents the analytical framework focusing on the simultaneous relationship between employment, income, and congestion. In the section three, we describe the measurement of congestion and data. Then we provide empirical findings. In the last section, we discuss our results and suggest transportation policy implications.

2. Analytical framework: a simultaneous equations model of employment, income, and congestion

Employment and income have an interdependency because both households and firms are mobile and free to change their locations. If households recognize better income opportunities in some locations, they are likely to migrate to the location in order to maximize their utility. Firms also can move to be near growing markets to maximize their profits by lowering production costs (Steinnes and Fisher, 1974; Carlino and Mills, 1987; Deitz, 1998). Thus, it is assumed that households and firms interact in an urban space. During this process, the location decisions of households and firms determine urban congestion level, and particularly growing population and employment density causes an increase in traffic congestion.

Current studies empirically demonstrated that severe traffic congestion decreases employment growth. It is argued that if agglomeration benefits in an urban area are lower than costs from the congestion, firms may relocate to other places (Hymel, 2009). Therefore, growing traffic congestion contributes to decreasing employment growth, which simultaneously causes a decrease in workers' wages or household income (Gebremariam et al., 2010; Greenwood and Hunt, 1984). On the other hand, growing jobs attracts labor forces and encourages households to migrate for better income opportunities. Rising incomes allow people to own private cars and this increases usage of vehicles (Crane, 1996), and growing jobs generates more trips. Consequently, growing jobs and incomes lead to higher urban traffic congestion. With consideration of this process, income and employment should be regarded as an endogenous variable in the transportation model (Bhat and Koppelman, 1993). In this study, we assume that there are relationships between employment, income, and traffic congestion as shown in Fig. 1.

This interrelationship can be explained through systems of simultaneous equations. Previous studies have adopted this methodology to investigate the relationship between employment growth and population growth (Clark and Murphy, 1996; Greenwood, et al., 1986; Kim, 2014), between per capita income and public expenditures (Duffy-Deno and Eberts, 1991), between population growth, employment growth, and income growth (Greenwood and Hunt, 1984), and between economic growth and environment policy (Nondo and Schaeffer, 2012). The fundamental concepts of this simultaneous equations model follow the work of Carlino and Mills (1987). As discussed above, we assume that there is an interdependency between income, employment, and congestion. The equilibrium level of income, employment, and congestion can be determined by household and business location choice factors and their influences on each other. Specifically, this relationship can be expressed as the following equations.

$$I_i^* = f\,(E_i^*,\ C_i^* \mid \Omega_I)$$

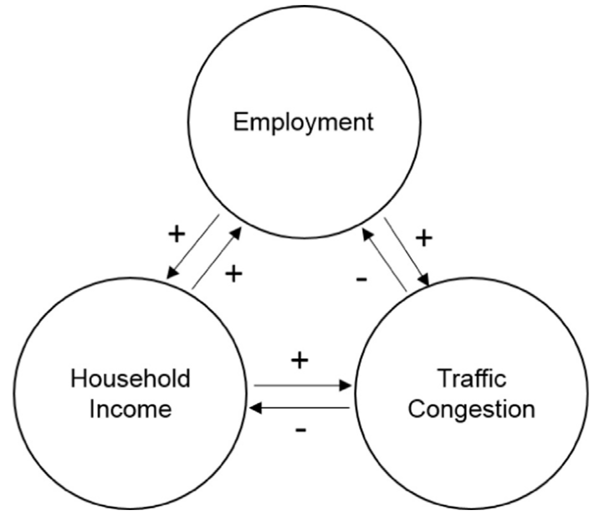

Fig. 1. Simultaneous relationship between traffic congestion, employment, and income.

$$E_i^* = f\,(I_i^*,\ C_i^* \mid \Omega_E)$$

$$C_i^* = f\,(E_i^*,\ I_i^* \mid \Omega_C)$$

I_i^*, E_i^*, and C_i^* represent equilibrium levels of income, employment, and congestion, respectively in the ith metropolitan area. Ω_I, Ω_E, and Ω_C represent a set of variables describing initial conditions and other exogenous variables that have either a direct or indirect effect on income, employment, and congestion. It is assumed that income, employment, and congestion are not fully adjusted, and they likely adjust to their equilibrium levels with substantial lags – their initial conditions (Mills and Price, 1984). With this assumption, the distributed partial adjustment models for the equilibrium levels of income, employment, and congestion are specified as follows;

$$I_{i,t} = I_{i,t-1} + \lambda_I\,(I_i^* - I_{i,t-1})$$

$$E_{i,t} = E_{i,t-1} + \lambda_E\,(E_i^* - E_{i,t-1})$$

$$C_{i,t} = C_{i,t-1} + \lambda_C\,(C_i^* - C_{i,t-1})$$

λ_I, λ_E, and λ_C represent the speed-of-adjustment coefficients to desired levels of income, employment, and congestion. It is assumed that they are positive and between 0 and 1. $t-1$ refers to the initial conditions of the endogenous variables. The equations show that current income, employment, and congestion are dependent on their initial conditions, on the change from their equilibrium values, and on the lagged values. After rearranging and substituting the above equations, we can finally obtain the proposed empirical model. Therefore, for investigation of the relationship between income, employment, and congestion, our empirical models are specified as follows;

$$\Delta I_{i,t} = \alpha_0 + \alpha_1 \Delta E_{i,t} + \alpha_2 \Delta C_{i,t} + \alpha_3 I_{i,t-1} + \alpha_4 E_{i,t-1} + \alpha_5 C_{i,t-1} + \sum \alpha_j \Omega_I + \varepsilon_i$$

$$\Delta \mathrm{E}_{i,t} = \beta_0 + \beta_1 \Delta I_{i,t} + \beta_2 \Delta C_{i,t} + \beta_3 I_{i,t-1} + \beta_4 E_{i,t-1} + \beta_5 C_{i,t-1} + \sum \beta_j \Omega_E + \mu_i$$

$$\Delta C_{i,t} = \gamma_0 + \gamma_1 \Delta I_{i,t} + \gamma_2 \Delta E_{i,t} + \gamma_3 I_{i,t-1} + \gamma_4 E_{i,t-1} + \gamma_5 C_{i,t-1} \quad + \sum \gamma_j \Omega_C + v_i$$

Our dependent variables, $\Delta I_{i,t}$, $\Delta E_{i,t}$, and $\Delta C_{i,t}$ represent income growth, employment growth, and congestion growth in each metropolitan area, respectively. $I_{i,t-1}$, $E_{i,t-1}$, and $C_{i,t-1}$ represent initial levels of income, employment, and congestion. Ω represents a vector of exogenous variables. The speed of adjustment to equilibrium level is embedded in the coefficients α, β, and γ (j=6, 7,.....,n). Our empirical simultaneous models can be estimated by a Three-Stage Least Square (3SLS) estimator because Ordinary Least Square (OLS) may produce biased estimate results in this case (Greenwood et al., 1986).