2013 Conference Proceedings

Mid-Continent
Regional Science Association
44th Annual Conference

May 29-31, 2013

InterContinental Kansas City at the Plaza
Kansas City, Missouri

Mid-Continent Regional Science Association
2013 Conference Proceedings

November 2013

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Mid-Continent Regional Science Association

2013 MCRSA Conference Proceedings

Perspectives on Regional Growth Policies: Implications from the Analysis of Regional Financial Markets

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Abstract. This paper examines regional growth policy options implied by an interactive model of regional financial markets and regional economic growth. A synthesis of regional financial market analyses by Harrigan and McGregor (1987) and Moore, Karaska, and Hill (1985) is the basis for an extended model of this interaction. The analysis combines a general model of regional financial markets with a Keynesian-type model of regional income and indicates directions public policies can take in the promotion of regional growth.

Introduction

The uneven growth of regional economies, especially reflected by lagging or negligible growth in many distressed local economies, has been the subject of concern by both academicians and policy makers for several decades. Many policy alternatives have been proposed and attempted in connection with the lack of growth exhibited in regional economies, including urban renewal, growth centers, enterprise zones, infrastructure expansion, and job training programs. An alternative and yet unexplored approach is the use of financial policies. The study of regional financial markets by Moore and Hill (1982), Moore, Karaska, and Hill (1985), Dow (1987), and Harrigan and McGregor (1987) indicate that financial activity is both regionally segmented and interactively tied to regional production activity. An extension of these studies implies that regionally based financial polices can be used to promote regional economic growth.

The theoretical interaction between financial markets and economic growth is particularly relevant to the persistence of lagging growth in rural counties. The importance of local credit markets to the local economy is likely to be more pronounced in smaller, agrarian, or resource-based communities than in larger, diversified metropolitan areas. The relative importance of structural ties between credit markets and production in rural counties suggests that financial problems are not only more serious, but financial policies are potentially more effective.

In principle, the vitality of local credit markets in small, rural communities is closely tied to the community's general level of economic activity. The flow of funds to credit markets facilitates the conduct of economic activity, and the level of economic activity determines the flow of funds to the credit markets. Investment in capital, made possible by funds from the local credit markets, stimulates economic activity. Economic progress then generates additional income, which provides funds to the credit markets for further capital investment.

The general interactive nature of regional financial markets and economic activity indicates a cumulatively reinforcing pattern of growth or decline. Once the direction of economic activity is set in motion, often by exogenous forces, a region is likely to rise or fall for several years. Although numerous policies have been proposed to remedy the problems associated with the cumulative decline of regional activity, few have considered the role local credit markets play in this process. The purpose of this study is to develop a policy perspective based on the interaction of local credit markets and regional production. The specific objectives of this research are first to identify the theoretical relationships between regional financial activity and economic growth, and second to explore policy implications derived from this analysis.

Regional Financial Markets

The main proposition of regional financial market studies is the existence of regional credit market segmentation, reflected by regional interest rate differentials. The existence of interest rate differentials is contrary to the conventional regional research that assumes interest rates are equalized by extremely, if not perfectly, mobile financial resources. In comparison to the relative immobility of physical capital, natural resources, and labor, the assumption of perfectly mobile financial capital implies that *nonfinancial* resources are the primary factors limiting and/or promoting regional development and *financial* resources play a passive role in the process. For this reason, theoretical studies and policy analyses have concentrated on the nonfinancial factors with little or no concern for the role played by financial resources in regional growth.

Two of the first studies to explicitly consider the spatial differentiation of financial activity were Beare (1976) and Fishkind (1977). Although both were concerned with the regional impact of national monetary policy and assumed that financial capital is perfectly mobile, they provided an impor¬tant foundation for later studies.

Roberts and Fishkind (1979) were the first to discuss a theory of regional financial markets, arguing that they exist due to differences in attitudes regarding risk, preferences pertaining to asset holdings, and information availability, all of which generate regional interest rate differentials. They also indicated that interest rate differentials are systematically related to the proximity of regional financial markets to national financial centers.

The model of regional financial markets was further enhanced by Moore and Hill (1982), which used a standard money multiplier analysis to illustrate how regional economic activity, and the subsequent demand for financial deposits, determines the availability of regional credit. In their model, the supply of regional credit is used to satisfy local demand with excess credit invested in national financial markets. Moreover, they argue that if regional credit demand exceeds the available supply, the regional financial market acts as a wholesaler, buying funds from the national financial market and, with an appropriate mark-up, supplying them to meet local demands.

Dow (1987) reinterpreted the Moore and Hill model by reversing the direction of causality. In contrast to Moore and Hill, Dow argued that the credit demanded in the regional financial market determines the amount of deposits needed for a given level of income. Dow used this interpretation to lay the groundwork for analyzing the impact of changes in the confidence level in the region brought about by an expanding or contracting economy.

The analyses by Moore and Hill and Dow suggest the importance of regional financial markets in promoting and/or limiting regional growth. In a growing region with a relatively high demand for credit, the regional financial market supplies both local credit and credit from national markets. However, in a less prosperous region with very little credit demand and a relatively low regional interest rate, the regional financial market redirects local funds to the national financial market and a relatively higher interest rate. A declining region with relatively little credit demand and thus a low regional interest rate will lose its local credit to the national financial market. Moreover, the lack of credit inhibits growth in the region and further constrains credit demand as the region spirals downward.

Harrigan and McGregor (1987) presented an expanded, more general model of regional financial markets that incorporates the two polar cases of regional financial activity – market segmentation and perfect financial capital mobility. Their model suggests how a declining region experiences cumulatively reinforcing problems and how local economies have different degrees of market segmentation and spatial financial interaction.

Extending the earlier work of Moore and Hill (1982), Moore et al. (1985) examine the interaction between regional credit and regional income, deriving a Keynesian-type regional income multiplier that incorporates the relationship between regional income and the supply of regional credit. By augmenting regional consumption expenditures, the supply of regional credit generates a greater regional income multiplier than traditionally identified. Moore et al.

emphasize the mutual interaction between income and credit and provide an important foundation for the analysis of regional financial markets and regional growth undertaken here.

A Model of Regional Financial Markets and Regional Income

The complete model of regional financial and regional income interaction is divided into a regional financial market submodel – based on the Harrigan and McGregor (H-M) analysis – and a Keynesian-type regional income submodel – based on the Moore, Karaska, and Hill (M-K-H) analysis.

The regional financial market submodel is specified as follows.

$$i_t^d = \Gamma_1\left(\lambda - \delta_1 CR_t^d + \delta_2 Y_t\right) + \Gamma_2\left(i_n - \mu\right) \tag{1}$$

$$i_t^s = \Psi_1\left(\phi + \sigma_1 CR_t^s - \sigma_2 Y_t\right) + \Psi_2\left(i_n + \mu\right) \tag{2}$$

$$i_t^d = i_t^s \tag{3}$$

$$CR_t^s = CR_t^d + CN_t \tag{4}$$

The regional income submodel is specified as follows.

$$Y_t = C_t + I_t + X_t - M_t \tag{5}$$

$$C_t = \alpha + \beta_1 Y_{t-1} + \beta_2 CR_{t-1}^c \tag{6}$$

$$I_t = I_t^n + I_t^1 \tag{7}$$

$$I_t^1 = \gamma + \kappa_1 Y_{t-1} + \kappa_2 CR_{t-1}^1 \tag{8}$$

$$M_t = \omega + \beta_1 f Y_{t-1} + \beta_2 f\, CR_{t-1}^c \tag{9}$$

$$CR_t^c = \rho CR_t^d \tag{10}$$

$$CR_t^1 = (1-\rho)\, CR_t^d \tag{11}$$

where i_t^d = the interest rate regional credit demanders are willing to pay, i_t^s = the interest rate regional credit suppliers are willing to accept, CR_t^d = demand for credit originating in the region, CR_t^s = supply of credit originating in the region, Y_t = regional income, i_n = the national interest rate determined in the national financial market, μ = transaction surcharge incurred by interaction between the national financial market and the regional financial market, CN_t = net amount of funds flowing from the regional financial market to the national financial market,[1] C_t = regional consumption expenditures, I_t = regional investment expenditures, X_t = regional exports, M_t = regional imports, CR_t^c = credit demanded for regional consumption expenditures, I_t^n = investment expenditures undertaken by nationally oriented firms that <u>do not</u> obtain credit from the regional financial market, I_t^1 = investment expenditures undertaken by locally oriented firms that <u>do</u> obtain credit from the regional financial market, CR_t^1 = credit demanded for regional investment expenditures by locally oriented firms, and t = subscript indexing time.

The coefficients Γ_1, Γ_2, Ψ_1, and Ψ_2 in equations (1) and (2) assume the values of (0, 1) depending on the relevant segment of the demand or supply curve. To capture the essence of the H-M financial market model, both equations represent kinked curves.[2] The demand and supply relationships in the H-M model contain sloped segments and perfectly elastic segments. The first term on the right side of equation (1) specifies the negatively sloped range of the demand curve. The second term specifies the horizontal range. If $\Gamma_1 = 1$ and $\Gamma_2 = 0$, the regional financial market is in the negatively sloped range, and if $\Gamma_1 = 0$ and $\Gamma_2 = 1$, the market is in the horizontal range. The same interpretation holds for Ψ_1 and Ψ_2 with respect to supply. The segmented

[1] This term is labeled "*I*" in the analysis of regional financial markets by Moore et al. (1985). However, to distinguish this term from capital investment expenditures in the Keynesian production submodel, the notation has been changed to *CN*.

[2] The demand curve kink occurs where $CR_t^d = 1/\delta_1\left(\lambda + \delta_2 Y_t - i_n + \mu\right)$ and the supply curve kink occurs where $CR_t^s = 1/\sigma_1\left(-\phi + \sigma_2 Y_t + i_n - \mu\right)$.

relationships, $\lambda - \delta_1 CR_t^d + \delta_2 Y_t$ and $\phi + \sigma_1 CR_t^s - \sigma_2 Y_t$, are assumed linear to simplify the mathematics. The slope parameters δ_1, δ_2, σ_1, and σ_2 are assumed to be positive, where a 1 subscript denotes the partial of credit demanded or supplied on the interest rate and a 2 subscript denotes the partial of income on the interest rate. Figure 1 summarizes the regional financial market specified by equations (1) – (4).

Other parameters of the model are: the marginal propensity to consume for income, β_1; the marginal propensity to invest for income, κ_1; the proportion of imported products paid to factors of production outside the region, *f*; the marginal propensity to consume for credit, β_2; the marginal propensity to invest for credit, κ_2; and the exogenous components of consumption, locally oriented investment, and imports, α, γ, and ω. The parameter ρ is the proportion of credit demanded by consumers, and $(1-\rho)$ is the proportion demanded by locally oriented businesses.[3]

The kinked nature of equations (1) and (2) implies three important short-run equilibrium alternatives.[4] In Alternative A, the economy is operating, respectively, in the negatively and positively sloped segments of the demand and supply curves such that Γ1 = 1, Γ2 = 0, Ψ1 = 1, and Ψ2 = 0. No interaction between the regional financial market and the national financial market indicates $CN_t = 0$ and $CR_t^d = CR_t^s$. In this case, equations (1) and (2) can be simplified as follows.

$$i_t^d = \lambda - \delta_1 CR_t^d + \delta_2 Y_t \tag{1a}$$

$$i_t^s = \phi + \sigma_1 CR_t^s - \sigma_2 Y_t \tag{2a}$$

In Alternative B, the demand curve is negatively sloped and the supply curve is horizontal, Γ1 = 1, Γ2 = 0, Ψ1 = 0, and Ψ2 = 1. The amount of regional credit demanded is greater than supplied, and there is a net flow of funds from the national financial market at the interest rate $i_n = \mu$, with $CN_t < 0$ in equation (4). Equations (1) and (2) can be simplified as follows.

$$i_t^d = \lambda - \delta_1 CR_t^d + \delta_2 Y_t \tag{1b}$$

$$i_t^s = i_n + \mu \tag{2b}$$

In Alternative C, the supply curve is positively sloped and the demand curve is horizontal, Γ1 = 0, Γ2 = 1, Ψ1 = 1, and Ψ2 = 0. The amount of regional credit supplied is greater than the amount demanded with a net flow of funds to the national financial market at the interest rate $i_n - \mu$ and $CN_t > 0$. Equations (I) and (2) can be stated as follows.

$$i_t^d = i_n - \mu \tag{1c}$$

$$i_t^s = \phi + \sigma_1 CR_t^s - \sigma_2 Y_t \tag{2c}$$

In the long run, the alternative realized in the regional financial market is determined by the magnitude of the shifts in the credit demand and supply curves attributed to shifts in regional income. If the demand and supply curves shift by the same relative amount, then Alternative A of complete market segmentation will be maintained. However, if the demand curve shifts relatively more than the supply curve, Alternative B is realized, the interest rate rises to the upper bound of $i_n + \mu$, and the financial market is in the elastic portion of the supply curve and the positively sloped portion of the demand curve. If the supply curve shifts more than the demand, then the lower interest rate bound is achieved at $i_n - \mu$ with Alternative C.

A comparison of the critical parameters determining which alternative is achieved in the long run is possible by solving equations (1a) and (2a) for CR_t^d and CR_t^s, respectively.

$$CR_t^d = \lambda/\delta_1 - (1/\delta_1) i_t^d + (\delta_2/\delta_1) Y_t \tag{1d}$$

$$CR_t^s = -\phi/\sigma_1 + (1/\sigma_1) i_t^s + (\sigma_2/\sigma_1) Y_t \tag{2d}$$

[3] Realistically, ρ is not a constant but varies with differential levels of consumption, investment, and income. However, conclusions from this analysis are not changed by assuming a constant division of credit between households and locally oriented business.

[4] A fourth alternative, $\Gamma_1 = 0$, $\Gamma_2 = 1$, $\Psi_1 = 0$, and $\Psi_2 = 1$, exists only if $\mu = 0$ and the horizontal segments of both curves coincide. While this is obviously a theoretical possibility, it provides no insight into the study of spatially segmented regional financial markets.

The relative magnitudes of $\partial CR_t^d / ZY_t$ and $\partial CR_t^s / ZY_t$, δ_2/δ_1, and σ_2/σ_1 indicate whether the regional interest rate will rise to the upper boundary of $i_n + \mu$ or the lower boundary of $i_n - \mu$. If $\delta_2/\delta_1 = \sigma_2/\sigma_1$, then changes in regional income will keep the regional interest rate between the boundaries marked by $i_n + \mu$ and $i_n - \mu$, with Alternative A effective. If $\delta_2/\delta_1 < \sigma_2/\sigma_1$, then the growth in regional income will move the regional interest rate to $i_n + \mu$, and Alternative B becomes effective. If $\delta_2/\delta_1 < \sigma_2/\sigma_1$, then the regional interest rate rises to $i_n - \mu$, making Alternative C in effect. Given that regional economies are likely to have different relative magnitudes of δ_2/δ_1 and σ_2/σ_1 and without *a priori* evidence to the contrary, the implications of each alternative are explored.

Reduced-Form Equations

Equations (1) - (4) can be solved for CR_t^d in terms of Y_t, exogenous variables, and parameters of the model. Substituting equation (4) into (2) and then equations (1) and (2) into (3) gives:

$$\Gamma_1\left(\lambda - \delta_1 CR_t^d + \delta_2 Y_t\right) + \Gamma_2\left(i_n - \mu\right) = \Psi_1\left(\varphi + \sigma_1\left(CR_t^d + CN_t\right) - \sigma_2 Y_t\right) + \Psi_2\left(i_n + \mu\right).$$

Simplifying and solving for generates:

$$CR_t^d = \frac{1}{\Gamma_1\delta_1 + \Psi_1\sigma_1}\begin{pmatrix}\Gamma_1\lambda - \Psi_1\varphi + \left(\Gamma_1\delta_2 + \Psi_1\sigma_2\right)Y_t + \\ \Gamma_2\left(i_n - \mu\right) - \Psi_2\left(i_n + \mu\right) + \Psi_1\sigma_1 CN_t\end{pmatrix}. \quad (13)$$

Equation (13) can be further simplified for each of the three alternatives identified above. For Alternative A the equation reduces to:

$$CR_t^d = \frac{1}{\delta_1 + \sigma_1}\left(\lambda - \phi + \left(\delta_2 + \sigma_2\right)Y_t\right). \quad (14)$$

For Alternative B it is:

$$CR_t^d = \frac{1}{\delta_1}\left(\lambda + \delta_2 Y_t - \left(i_n + \mu\right)\right), \quad (15)$$

and for Alternative C it is:

$$CR_t^d = \frac{1}{\sigma_1}\left(-\phi + \sigma_2 Y_t + \left(i_n - \mu\right) - \sigma_1 CN_t\right). \quad (16)$$

Noting that Alternative C generates short-run equilibrium in the perfectly elastic segment of the demand curve, the value of CR_t^d identified in equation (16) is equal to the value of CR_t^d at the demand curve kink, the maximum amount of credit demanded from regional sources. Equation (16) can be rewritten as:

$$CR_t^d = \frac{1}{\sigma_1}\left(-\phi + \sigma_2 Y_t + \left(i_n - \mu\right)\right) - \frac{\sigma_1}{\sigma_1} CN_t. \quad (17)$$

The second term on the right side of equation (17) is CN_t, the net flow of funds between the regional and national financial markets. Given equation (4), rewritten as $CR_t^d = CR_t^s - CN_t$, the first term on the right side is CR_t^s, the total amount of credit supplied from regional sources. Equation (17) indicates that only a portion of the credit is used within the region, CR_t^d, and the remainder flows to the national financial markets, CN_t.

Because the amount of credit supplied has no bearing on CR_t^d in the perfectly elastic segment of the demand curve, and because the maximum amount of credit demanded is given by the kink in the demand curve, equation (16) can be substituted with the specification for the demand curve kink. Letting $\lambda - \delta_1 CR_t^d + \delta_2 Y_t = i_n - \mu$ and solving for CR_t^d, the demand curve kink is:

$$CR_t^d = \frac{1}{\delta_1}\left(\lambda + \delta_2 Y_t - \left(i_n - \mu\right)\right). \quad (18)$$

Equation (18) is the appropriate reduced-form equation for Alternative C within the context of credit stimulated regional growth.

Equations (5) - (11) can be solved for Y_t in terms of CR_t^d, exogenous variables, and the parameters of the model. Repeated substitution into equation (5) generates:

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 \rho CR_{t-1}^d + I_t^n + \gamma + \kappa_1 Y_{t-1} + \kappa_2 (1-\rho) CR_{t-1}^d \\ + X_t - \omega - \beta_1 f Y_{t-1} + \beta_2 f \rho CR_{t-1}^d . \quad (19)$$

Combining terms and simplifying gives the reduced form:

$$Y_t = \alpha + \gamma - \omega + I_t^n + X_t + \left(\beta_1 \left(1-f\right) + \kappa_1\right) Y_{t-1} \\ + \left(\beta_2 \left(1-f\right) \rho + \kappa_2 (1-\rho)\right) CR_{t-1}^d . \quad (20)$$

Implications for Regional Growth

Separately combining equations (14), (15), and (18) with equation (20) generates first-order difference equations that can be used to identify conditions for regional growth.

Alternative A: Complete Market Segmentation

Substituting equation (14) into equation (20) gives:

$$Y_t = \alpha + \gamma - \omega + I_t^n + X_t + \left(\beta_1 \left(1-f\right) + \kappa_1\right) Y_{t-1} \\ + \left(\beta_2 \left(1-f\right)\rho + \kappa_2 (1-\rho)\right)\left[\frac{1}{\delta_1 + \sigma_1}\left(\lambda - \phi + \left(\delta_2 + \sigma_2\right) Y_{t-1}\right)\right] . \quad (21)$$

Combining terms simplifies equation (21) to:

$$Y_t = \alpha + \gamma - \omega + I_t^n + X_t + \left(\beta_2 \left(1-f\right)\rho + \kappa_2 (1-\rho)\right)\left[\frac{\lambda - \phi}{\delta_1 + \sigma_1}\right] \\ + \left[\beta_1 \left(1-f\right) + \kappa_1 + \left(\beta_2 \left(1-f\right)\rho + \kappa_2 (1-\rho)\right)\left[\frac{\delta_2 + \sigma_2}{\delta_1 + \sigma_1}\right]\right] Y_{t-1} . \quad (22)$$

Equation (22) is a first-order difference equation of the form

$$Y_t = \pi + \theta Y_{t-1} \quad (23)$$

where:

$$\pi = \alpha + \gamma - \omega + I_t^n + X_t \\ + \left(\beta_2 \left(1-f\right) \rho + \kappa_2 (1-\rho)\right)\left[\frac{\lambda - \varphi}{\delta_1 + \sigma_1}\right] \quad (24)$$

$$\theta = \beta_1 \left(1-f\right) + \kappa_1 \\ + \left(\beta_2 \left(1-f\right) \rho + \kappa_2 (1-\rho)\right)\left[\frac{\delta_2 + \sigma_2}{\delta_1 + \sigma_1}\right] . \quad (25)$$

The solution to equation (23) is given by:[5]

$$Y_t = A\theta^t + \frac{\pi}{1-\theta} . \quad (26)$$

The stability of equation (23) is determined by the value of θ. The growth path of Y_t oscillates at a constant amplitude if $\theta = -1$, a decreasing amplitude if $-1 < \theta < 0$, and an increasing amplitude if $\theta < -1$. The growth path of Y_t is monotonic and constant if $\theta = 1$, decreasing if $0 < \theta < 1$, and increasing if $\theta > 1$. Given that all parameters in equation (25) are positive and $f < 1$, $\rho < 1$, it can be unambiguously stated that $\theta > 0$, indicating that the growth path of Y_t is monotonic. However, the key question in this analysis is θ relative to unity. If $\theta > 1$, regional growth is increasing; if $\theta < 1$, growth is decreasing; and if $\theta = 1$, growth is constant. In particular, the critical aspect is the role regional financial markets play in this process.

Equation (25) can be divided into two parts. The first term on the right side, $\beta_1(1 - f) + \kappa_1$, is the standard multiplicative effect of income on itself, including consumption, locally oriented investment, and imports. Without including regional financial activities, this term would be the exclusive determinant of the growth path in equation (22). However, with financial activities the direct multiplicative effect of income is reinforced by the indirect effect through credit, which is given by the second term on the right side of equation (25). This second term itself can be divided into two parts, the first

[5] The solution to equation (22), if $\theta = 1$, is given by $Y_t = a + bY_{t-1}$. Although this is a distinct possibility, the more interesting alternatives exist if $\theta > 1$ or $\theta < 1$ and will be the primary topic of this discussion.

indicating the effect of credit on income and the second indicating the effect of income on credit.

While it is not possible to determine *a priori* whether $\theta > 1$, it is evident that financial market activities augment the growth caused solely by multiplicative income effects.[6] Even if the direct multiplicative effect of income is not enough to generate explosive growth, it is possible that the added indirect effect of income through credit activities could be enough to generate this type of growth.

In terms of equation (25) larger values for the marginal propensity to consume, β_1, the marginal propensity to invest, κ_1, and the proportion of factor payments that stay in the region, $(1 - f)$, add to the cumulative growth potential from both the direct income and indirect credit effects. However, the second term in equation (25) indicates that parameters in the regional financial market can play a critical role in the growth potential. The more sensitive the interest rate is to income, δ_2 and σ_2, and the less sensitive the interest rate is to credit, δ_1 and σ_1, the greater the indirect credit impact will be.

Alternative B: Demand-Dominated Financial Market

In contrast to Alternative A in which the regional financial market is completely segmented from the national market, Alternative B indicates that when the amount of regional credit demanded exceeds the amount regionally supplied there is a net flow of funds from the national financial market at $i_n + \mu$. A solution in this situation requires the substitution of equation (15) into equation (20), which simplifies into the following first-order difference equation.

$$Y_t = \alpha + \gamma - \omega + I_t^n + X_t + \left(\beta_2(1-f)\rho + \kappa_2(1-\rho)\right)\left[\frac{\lambda - (i_n + \mu)}{\delta_1}\right]$$
$$+\left[\beta_1(1-f) + \kappa_1 + \left(\beta_2(1-f)\rho + \kappa_2(1-\rho)\right)\left[\frac{\delta_2}{\delta_1}\right]\right]Y_{t-1} \tag{27}$$

Equation (27) is nearly identical to equation (22) except for the terms $\left(\lambda - (i_n + \mu)\right)/\delta_1$ and δ_2/δ_1. As might be expected, since the regional financial market equilibrium is determined by the amount of regional credit demanded, coefficients derived from the regional credit supply function have dropped out.

The similarities between equations (27) and (22) indicate that the same conclusions are derived with one exception. Although the stability of the growth path of Y_t depends on the combined direct income multiplier effect and indirect credit effect, in Alternative B the indirect effect is based exclusively on the demand side of the regional financial market. The supply side of the financial market is completely passive. Regional growth is more likely to be explosive if the demand for credit is more sensitive to income, *regardless* of the relationship between the supply of credit and income.

This conclusion is contrary to the results from the M-K-H model. The conventional income multiplier derived from the M-K-H model is augmented by deposit ratios and reserve requirements, based on the *supply* side of the financial market. A consideration the H-M model of regional financial markets indicates that under circumstances in which the amount of regional credit demanded exceeds the amount supplied, the growth of income is based on the *demand* side of the financial market.

Alternative C: Supply-Dominated Financial Market

The last alternative occurs when the amount of regional credit supplied exceeds the amount demanded and the regional financial market is operating in the perfectly elastic segment of the demand curve. The solution under this alternative is obtained by substituting equation (18) into equation (20), which simplifies as:

[6] This result is consistent with the expanded income multiplier derived by Moore et al. (1985). However, analysis of Alternative C indicates that while the results of both models agree in general, they contradict in the specific manner in which financial activity augments production.

$$Y_t = \alpha + \gamma - \omega + I_t^n + X_t + \left(\beta_2 \left(1 - f\right)\rho + \kappa_2 \left(1 - \rho\right)\right)\left[\frac{\lambda - \left(i_n - \mu\right)}{\delta_1}\right] \tag{28}$$
$$+ \left[\left(\beta_1 \left(1 - f\right) + \kappa_1 + \beta_2 \left(1 - f\right)\rho + \kappa_2 \left(1 - \rho\right)\right)\left[\frac{\delta_2}{\delta_1}\right]\right] Y_{t-1}.$$

Equation (28) is identical to equation (27) with one minor difference: the arbitrage surcharge, μ, is subtracted from rather than added to the national interest, which occurs because the regional financial market is in the perfectly elastic portion of the demand curve rather than the supply curve.

However, the similarities are more important. Even though Alternative C occurs because the amount of regional credit supplied exceeds the amount regionally demanded, *none* of the parameters from the supply equation are included in equation (28). This indicates that the growth path of regional income, like Alternative B, is exclusively determined by the demand side of the regional financial market. This apparent paradox occurs because the excess of regional credit supplied over regional credit demanded flows to the national financial market, $CN_t > 0$, and thus has *no* impact on income activity within the region. The growth path of income is determined by the amount of credit demanded, not supplied. This further implies that analyses such as that undertaken with the M-K-H model, focusing on deposit multipliers, reserve ratios, and the regional money supply, ignore the more important demand side of the financial activity.

Analysis of Alternatives B and C indicate the importance of credit demand relative to credit supply. The degree of sensitivity of credit demand to regional income reinforces increasing or decreasing growth attributable to the standard expenditures multiplier effect. The available supply of credit is less important to growth than the demand for credit.

Regional Income Multiplier

The importance of credit demand over credit supply is further reinforced by derivation of a regional income multiplier analogous to that in the M-K-H analysis. This can be accomplished using equation (28)[7] and, after dropping the now unneeded time subscript *t*, solving for *Y* in terms of the parameters and exogenous variables.

$$Y = \frac{1}{1 - \left(\beta_1 \left(1 - f\right) + \kappa_1 + \left(\beta_2 \left(1 - f\right)\rho + \kappa_2 \left(1 - \rho\right)\right)\delta_2 / \delta_1\right)} E \tag{29}$$

where the exogenous variables *E* are specified as:

$$E = \alpha + \gamma - \omega + I^n + X + \left[\left(\beta_2 \left(1 - f\right)\rho + \kappa_2 \left(1 - \rho\right)\right)\frac{\delta_2}{\delta_1}\right]\left[\frac{\lambda - \left(i_n - \mu\right)}{\delta_1}\right] \tag{30}$$

The first term in equation (29) is the income multiplier analogous to that derived by M-K-H. The key difference between this multiplier and the M-K-H multiplier is the term δ2/δ1, which captures the importance of credit demand, and replaces the term $(d - dr + t - tr')(1 - i_0)$, which captures credit supply. Although conclusions here support those from the M-K-H analysis that regional income multipliers are understated if regional financial activity is not included, they differ in the magnitude of the understatement. The multiplier in equation (29) is less than the M-K-H multiplier for Alternative C, with an excess supply of regional credit, and greater for Alternative B, with an excess demand for regional credit.

Policy Implications

Equations (22), (27), and (28) highlight several exogenous and endogenous regional economic development policies that have been frequently discussed in the literature, including increasing exogenous consumption (α), investment (γ, I_t^n), and exports (X_t); reducing exogenous imports (ω); increasing the marginal propensity to consume for income (β_1), the marginal propensity to invest for income (κ_1), and reducing payments to factors of production outside the region (*f*).

However, of greater interest for this analysis are additional policies that surface in the context of the regional financial market that can be used to externally stimulate the regional economy or increase the size of

[7] Equation (27) derived for Alternative B generates essentially the same results except that the arbitrage surcharge μ is added to the national interest rather than subtracted. The income multiplier is exactly the same in both cases.

the regional multiplier effect. With complete market segmentation, as is the case in equation (22), the national interest rate (i_n) has no external stimulation. However, the national interest rate has a differential effect on regional activity for Alternatives A and B, depending whether demand or supply dominates the regional financial market. If demand dominates and the regional financial market is in the elastic portion of the supply curve, a decrease in the national interest rate will stimulate the regional economy. If supply dominates and the regional financial market is in the elastic portion of the demand curve, then an increase in the national interest rate is needed to stimulate the regional economy. With Alternative B, the regional economy is stimulated through a reduction in the arbitrage surcharge (μ). The reverse is true with Alternative C. Thus a key implication from this analysis is that identical policies have different effects for different regions, depending on whether the region is in the elastic portion of the credit demand or supply curves. A unilateral, national policy will not enhance growth in all regions simultaneously.

The importance of this conclusion is revealed in the context of bank failures that occurred during the 1980s. While the nominal money supply increased at an average annual rate of about 8% from 1981 to 1987, over 600 banks failed nationwide. Moreover, over half of that total was located in Texas, Oklahoma, Kansas, Nebraska, and Iowa. Adding four other states, Missouri, Colorado, Louisiana, and Minnesota, accounts for 70% of the total. The fact that 70% of all bank failures in the 1980s occurred in nine states in an era of expansionary monetary policy suggest the existence of differential structural parameters. The existence of differential structural parameters further suggests that some states were prevented from obtaining the benefits of the national expansionary monetary policy or, even worse, the structural differences between states may have turned the expansionary monetary policy on its head, contributing to economic and financial problems and subsequent bank failures in these states.

Policies that enhance the regional economy through structural changes in the financial market center on six key parameters (β_2, κ_2, δ_1, σ_1, δ_2, σ_2). All three equations (22), (27), and (28) indicate that increases in the marginal propensity to consume (β_2) or to invest (κ_2) from borrowed credit will increase the multiplicative effect of external changes. Similar results are obtained if the income sensitivity of the interest rate for demand (δ_2) and supply (σ_2) are increased. The demand parameter (δ_2) indicates the degree to which locally oriented business and consumers utilize borrowed funds to conduct expenditures when regional income increases. The supply parameter (σ_2) captures the ability of the regional economy to transform deposits, stimulated by regional income, into loans based on reserve requirements, excess reserves, and lending policies of financial institutions. Reductions in the credit sensitivity of the interest rate for demand (δ_l) and supply (σ_1) have the same effect on the regional economy as increases in the income parameters.

It is important to emphasize that parameters for the credit demand side of the regional financial market are significant for any of the three alternatives. However, unless the regional financial market is completely segmented from the national market, credit supply parameters have *no* effect. Financial policies designed to stimulate regional growth should concentrate on the demand side of the financial market if the regional and national markets are not completely segmented.

Conclusions

This analysis of regional financial markets and regional growth is based on an extension and synthesis of the models developed by Harrigan and McGregor (1987) and Moore et al. (1985). One important conclusion from this analysis is that the interactive relationship between credit and income indirectly contributes to the growth of regional income by reinforcing conventional expenditure multiplier effects. This analysis indicates that regional financial activity should not be ignored in the study of regional growth. A second important conclusion is the key role played by regional credit demand in both the operation of regional financial markets and the pattern of regional growth. Unless the regional financial market is completely segmented from the national market, the demand side of the financial market is the critical link to regional income. Credit supply neither constrains nor promotes regional growth, because excess regional demand is satisfied from national sources and excess regional supply flows to the national financial market. The importance of regional credit demand resulting from locally oriented firms and households is a key factor for promoting regional growth through alternative financial policies.

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Economic Impacts of the Paper and Allied Products Industry in the South

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Abstract. The paper and allied products industry is an important component of the South's economy. Within the broader forest products industry, the paper and allied products industry is the largest contributor to the region's economy. Declines in domestic paper demand due to the recent recession, increases in international competition, climate change issues, and consumers' increasing preference for electronic versus paper media have substantially affected this industry. Thus, assessing its economic contribution is crucial. Impact Analysis for Planning (IMPLAN), an input-output modeling system, was used to assess the economic contribution of the paper and allied products industry for 13 southern states for 2009. Two aspects of economic contribution, direct impacts and the associated Social Accounting Matrix (SAM) multipliers, were estimated. Direct impacts, initial impacts on the economy, are measured by the employment, wages and salaries, total industry output, and value-added of the industry. In 2009, the paper and allied products industry's value of shipments and manufacturing value-added accounted for 8.23% and 9.78% of the South's total. The average annual wages and salaries for its employees was $84,000, which was about 1.8 times larger than the average annual wage across all employees in the South. SAM multipliers were also higher than the other forest products sectors' multipliers. Thus, the paper and allied products industry was an important source of economic activity in the South. This study updates economic information about the paper and allied products industry and will be helpful in addressing critical economic issues pertaining to this sector.

Keywords: IMPLAN, multipliers, impact analysis

Introduction

Economic impact of the global pulp and paper products industry in 2006 was U.S. $201 billion, of which 26.17% was generated by the U.S. pulp and paper products industry (FAO, 2011). U.S. pulp and paper industry's employment was more than 391,000 (AF&PA, 2012). In 2001, the South's paper and allied products industry represented 48.6% of the South's forest products industry's output (Tilley and Munn, 2007a) and 35.2 % of total U.S.'s paper and allied products industry's employment (Tilley and Munn, 2007b). The South is the leading producer of timber in the world (Prestmon and Abt, 2002) and covers the largest percentage of U.S. forest land, 214 million acres (Alvarez, 2007). The South's paper and allied products industry is the largest manufacturing sector among the forest products sectors measured in terms of total income, personal income, total output, and value-added (Tilley and Munn, 2007a). Therefore, the paper and allied products industry is the most important forest products component of the South's economy.

The paper and allied products industry depends on other sectors of the forest products industry for raw materials. The logging industry harvests and delivers timber and the solid wood products sector provides wood chips and sawdust as byproducts of its manufacturing process. Changes in production of any industry from which the raw materials are obtained affect the paper and allied products industry which in turn affects other industries. For example, a decline in the production of paper and allied products will affect wholesale trade businesses, food services and drinking, commercial logging, and transportation. Thus, industries are interdependent on each other and economic shocks to one industry ripple throughout the industry. The recession from 2007 to 2009 and housing slump in 2006 greatly impacted the southern forest products industry (Woodall et al., 2011). There were 1,022 mill closures during 1999 to 2009, causing the loss of thousands of forest products industry jobs (Brandies et al., 2012). The paper and manufacturing sector alone lost more than 27,000 jobs from 2001 to 2005 (Hodges et al., 2011). In addition, declines in domestic paper demand, increasing international competition, climate change issues, and increasing consumer preference for electronic media have substantially affected the paper and allied products industry. Thus, assessing the economic contribution of the industry over time is crucial.

Economic contributions of the paper and allied products industry were estimated in terms of direct impacts and associated Social Accounting Matrix (SAM) multipliers. Changes due to immediate impacts of the industry refer to the direct impacts (Perez-Verdin et al., 2008) and reflect the magnitude of the industry's own activity. Indirect impacts result from supporting industries' economic activity necessary to provide the inputs demanded by the paper and allied products industry, and induced impacts result from changes in household spending due to direct and indirect impacts. SAM multipliers reflect the chain of direct impacts to the rest of the economy. They are calculated by summing direct, indirect, and induced impacts, then dividing by direct impacts. They differ from Type II and Type III multipliers in the sense that in SAM multipliers the induced impacts are calculated based on the social account matrix (Lindall and Olson, 1996) whereas Type II multipliers are based on assumption of linear relationship between income and expenditure which is unrealistic and Type III multipliers are complex in computation as there may be number of ways where relationship between income and expenditure is non-linear. SAM multipliers are easy to compute in IMPLAN and are more accurate than type II multipliers.

This study updates and compares the economic indicators for the paper and allied products industry originally provided by Tilley and Munn (2007a and 2007b) both in nominal and real dollars. Results from this study will be helpful for policy makers to understand and address critical economic issues relevant to the paper and allied products industry. In addition, this study will help track industry trends. Consequences of factors affecting the decline in paper and allied products industry's economic activity are estimated in terms of employment, wages and salaries, output, and value-added.

Materials and Methods

Economic contributions of the paper and allied products industry were derived using the Impact Analysis for Planning (IMPLAN) model. IMPLAN is currently managed by Minnesota IMPLAN Group (MIG). MIG develops software for impact analysis and generates yearly data. This study used IMPLAN version 3.0 software and 2009 data. IMPLAN is an input-output model and provides a quantitative approach to assessing economic impacts (Murthy and Cubbage, 2004). The current IMPLAN model, which was updated after the release of Bureau of Economic Analysis (BEA) Benchmark input-output data in 2002, consists of 440 industrial sectors. Tilley and Munn (2007a and 2007b) used a previous version consisting of 509 industrial sections. A bridge table provided by MIG (www.implan.com) was used to relate the sectors in the current model to the previous one. One of the advantages of IMPLAN is that users can aggregate different industrial sectors as they desire (Rickman and Schwer, 2001). For reporting purposes, the impacts of the following nine IMPLAN sectors were aggregated to form the paper and allied products industry: pulp mills; paper mills; paperboard mills; paperboard container manufacturing; coated and laminated paper, packaging materials; all other paper bag and coated and treated paper bag manufacturing; stationary product manufacturing; sanitary paper product manufacturing; and all other converted paper product manufacturing.

IMPLAN models were constructed for 13 southern states (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia) and economic impacts were derived for the paper and allied products industry. Current levels of outputs, when used as initial effects to run IMPLAN models for contribution analysis of multiple industries, generate total economic indicators (employment, output, wages and salaries, and value-added) in each sector whose sum is greater than that for the total industry as reported by IMPLAN. Therefore, total output reported in the IMPLAN database was adjusted to account for how a specific industry responds to an impact on itself. This adjusted value was then used as the initial effects for the impact analysis. Thus, adjustments were made to the initial effects at the disaggregated level so that the final demand values would equal the total output value for that industry. For example, output for the paper and allied products industry reported from IMPLAN database for Alabama in 2009 was $8,417.06 million. Each subsector of the paper and allied products industry was then adjusted to account for self-induced impacts and total output ($8,156.98 million) was used as the initial impact to estimate the indirect and induced impacts of the industry. The thirteen southern states were then combined to generate regional economic impacts of the paper and allied products industry. This study reports only the regional economic impacts of the paper and allied products industry.

Value of shipments and manufacturing value-added for paper manufacturing [North American Industrial Classification System (NAICS) code 322] were obtained from the 2009 Annual Survey of Manufacturers (USDC, 2009). Gross state products values were obtained from U.S. Department of Commerce Bureau of Economic Analysis (USDC BEA, 2011). The paper and allied products industry's wages and salaries were compared to 2001 in real dollars. To account for inflation, 2009 dollars were deflated to 2001 dollars using 2009 IMPLAN database deflators. Thus, comparisons were made both in nominal and real dollars. Tilley and Munn (2007a) calculated average SAM multipliers for the paper and allied products industry. Therefore, for comparison purposes, SAM multipliers were calculated by taking the means of the 13 southern states' paper and allied products industry type SAM multipliers.

Results and Discussion

Paper and allied products industry's total economy

The South's total industry employment increased from 54,290,945 in 2001 to 57,143,482 in 2009, a 5.25% increase (Table 1). Over the same period, the paper and allied products industry's employment decreased by 26.01%. The paper and allied products industry's employment represented 0.36% of the total regional employment in 2001 but decreased to 0.26% in 2009. Regional wages and salaries increased by 39.31% in nominal dollars and 7.98% in real dollars from 2001 to 2009 (Table 1). Although the industry wages and salaries increased by 3.23% in nominal dollars, they decreased by 17.02% in real dollars during the period examined. Average annual wages and salaries for the paper and allied products industry in 2009 was $84,000, $37,000 higher than that of the South. Average annual wages and salaries increased by 39.52% in nominal dollars and 12.15% in real dollars during the study period for the paper and allied products industry.

Table 1. Paper and allied products industry employment and wages and salaries of the South derived from the IMPLAN database

	Employment		Wages and salaries ($MM)		
			Nominal terms (current dollars)		Real terms
	2009	2001[a]	2009	2001[a]	In 2001 dollars
Paper & allied products industry	145,788	197,037	12,198.10	11,816.40	9,805.58
South total	57,143,482	54,290,945	2,705,635.50	1,942,181.80	2,097,201.70

[a] Tilley and Munn 2007a

In 2009, the paper and allied products industry's total output and value-added represented 0.98% and 0.52% to the South's total industry output and value-added, respectively. The paper and allied products industry total output and value-added increased by 42.68% and 26.97% respectively in nominal dollars during the study period (Table 2).

Table 2. Paper and alli ed products industry total indus try output and value-added of the Sout h derived from IMPLAN database

	Total industry output ($MM)		Total value-added ($MM)	
	2009	2001[a]	2009	2001[a]
Paper & allied products industry	79,991.10	56,064.20	23,135.90	18,221.60
South Total	8,156,392.10	5,377,658.70	4,407,927.20	2,998,482.00

[a] Tilley and Munn 2007a

Paper manufacturing (NAICS 322) value of shipments and manufacturing value-added accounted for 8.23% and 9.78% to the South's value of shipments and total manufacturing value-added respectively in 2009 (Table 3). Paper and allied products manufacturing value-added as a percentage of gross state product was 1.48%.

Table 3. 2009 Value of shipments, manufacturing value-added and gross state product of the South

	Value of shipments ($Bn)	Manufacturing value-added ($Bn)	GSP ($Bn)
NAICS 322	133.36	64.41	4,356.26
Total Industry	1,621.23	658.29	
Percentage	8.23	9.78	

Economic impacts of the paper and allied products industry

The direct impacts ($76,793.39 million) stimulated an additional $34,062.43 million of indirect impacts and $23,903.37 million of induced impacts, totaling $137,759.18 million (Table 4). Employment impacts of the paper and allied products industry were 140,736 direct jobs, 191,904 indirect jobs, and 576,802 induced jobs. Associated type SAM multipliers were 1.79 for gross output and 4.10 for employment. This means that each dollar produced by the paper and allied products industry generates additional $0.79 output and each job generated by the industry generates additional 3.10 jobs. Total wages and salaries and value-added generated by the paper and allied products industry were $31,245.02 million and $55,385.19 million.

Table 4. 2009 Economic impacts of the paper and allied products industry

Impacts	Employment	Wages and salaries ($MM)	Value-added ($MM)	Output ($MM)
Direct	140,736	11,732.52	22,188.82	76,793.39
Indirect	191,904	10,176.02	16,792.50	34,062.43
Induced	244,162	9,336.48	16,403.87	26,903.37
Total	576,802	31,245.02	55,385.19	137,759.18
Type SAM	4.10	2.66	2.50	1.79

The South-wide average SAM multipliers for the paper and allied products industry were 1.57 for output, 2.55 for employment, 1.94 for value-added, and 1.94 for wages and salaries (Tilley and Munn 2007a). In 2009, average type SAM multipliers were 1.76 for output, 4.03 for employment, 2.44 for value-added, and 2.61 for wages and salaries. This indicates that the paper and allied products industry in 2009 generated more indirect and induced impacts per unit of direct output compared to 2001.

Conclusion

The objective of this study was to estimate the impact of the paper and allied products industry and to identify changes in economic contribution from 2001 to 2009. The industry's economic contribution contracted substantially over the study period due to the recent recession. Although the industry's employment and real wages and salaries decreased during the study period, output and value-added increased. This implies that the industry became more capital intensive in order to increase production during the economic downturn and to meet the international competition. In addition, consumers' increasing preference for electronic media and climate change issues might have severely affected paper and allied products industry.

Employment in the industry had been decreasingly slowly over the long term; however, it was impacted severely during the recession period. In 1992 industry's direct employment was 210,105 (Aruna et al., 1997), in 1997 employment decreased to 201,589 (Abt et al., 2002), and then to 197,037 in 2001 (Tilley and Munn, 2007a). During the nine year period (1992-2001), employment decreased by 6.13%. Brandies et al. (2012) reported pulp and paper industry's employment of 64,295 and pulp and paper products industry's employment of 109,411, for a total of 173,706 jobs in 2004. The decrease in industry employment over the three year period (2001-2004) was 11.84%, nearly double to 1992-2001 period. In 2009, industry employment was 145,788, a decrease of 16.07% since 2004. This suggests that the recent recession and other adverse factors had disproportionately impacted the paper and allied products industry.

Type SAM multipliers for paper and allied products industry were higher in 2009 than in 2001. Average annual wages and salaries for the industry were $37,000 higher than the South's economy-wide average wages and salaries. Average annual wages and salaries for the industry have also increased since 2001. These facts suggest that although the industry economy shrunk during the study period, it is still a major contributor to the South's economy and generated proportionately higher indirect and induced effects in 2009 than 2001.This study updates the baseline economic information of the paper and allied products industry which can be helpful in policy implication and guideline formulation to help restore the paper and allied products industry.

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Proposed Changes to IMPLAN's Trade Flow Model

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Abstract. Determining commodity import and export flows are fundamentally important to deriving regional social accounting matrices. In 2005, MIG, Inc. developed a doubly-constrained gravity model to estimate trade flows for 440 commodities between all counties in the U.S. These trade flows give a fuller picture of economic relationships and impacts, and allow for Multi-Regional Input-Output (MRIO) analysis. This study explores two enhancements to the gravity model: the use of commodity-specific shipment costs and the use of commuter flows as a calibrator for the trade of residentiary services.

Introduction

IMPLAN, provided by MIG, Inc., is a data and software system used for building Social Accounting Matrix (SAM) models at the national, state, county, or zip-code level. By showing the linkages between industries and institutions, IMPLAN gives detailed insight into the structure of economies and what the economic impacts of a project or action might be.

Determining commodity import and export flows are fundamentally important to deriving regional social accounting matrices. In 2005, MIG, Inc., developed a doubly-constrained gravity model to estimate trade flows for 440 commodities between all counties in the U.S. These trade flows give a fuller picture of economic relationships and impacts, and allow for Multi-Regional Input-Output (MRIO) analysis.

Problem Statement and Study Purpose

IMPLAN's gravity model[1] requires data on the distances between each county pair, as well as the supply and demand of each commodity in each county. The supplies and demands of each commodity by county are available from MIG's annual datasets. Because commodities and consumers do not travel as the crow flies, great circle distances (gcd) are not an accurate way to estimate the travel distance between two counties. Thus, "impedances" developed by the Center for Transportation Analysis at Oak Ridge National Laboratory (ORNL) are used instead. These impedances account for tolls, congestion, and other factors to derive a travel cost index from each county centroid to every other county centroid in the U.S. by mode of transportation (truck, rail, water, and multimodal). These impedances include those within a single county – i.e., intra-county impedances. The multimodal option is basically a least-cost distance between the two centroids, using whichever mix of travel modes is the least costly.

MIG currently uses the least-cost modal mix under the presumption that producers will aim to minimize their shipping costs. However, while this least-cost modal mix is specific to each county-county pair, it is not specific to the particular commodity being shipped, and thus may not make sense for producers of non-bulk items (e.g., small shipments of a variety of items) or time-sensitive items, which would lend themselves better to truck transportation than to rail or water. The first part of this analysis will explore the option of creating a new set of multi-modal impedances depending on which commodity is being shipped.

MIG currently calibrates the trade flows against the average-ton-miles-moved data from the Commodity Flow Survey (CFS) [2]. However, the CFS provides average-ton-miles for shippable commodities (i.e., non-services) only; there no calibrator currently available for

[1] For more on IMPLAN's gravity model, see Olson et al. (2005).

[2] The CFS is a joint effort by the Research and Innovative Technology Administration (RITA), Bureau of Transportation Statistics (BTS), and the U.S. Census Bureau. It is conducted roughly every five years.

the service sectors. The second part of the analysis will explore the use of average commuting distances as a calibrator for the county to county flow of services.

Methodology

Commodity-Specific Multi-Modal Impedances

The Commodity Flow Survey (CFS) contains information on the value, weight, distance traveled, transportation mode, and origin and destination state of the shippable commodities. These commodities are classified according to the standard classification of transported goods (SCTG) system, and the survey data are reported at the two-digit SCTG level. The tables from the CFS provide three important pieces of information relevant to the gravity model:

1. Mode of transportation by commodity
2. Tons by distance shipped
3. Ton-miles shipped

The CFS Table "Shipment Characteristics by Two-Digit Commodity and Mode for the United States" shows the proportion of total commodity value, tons, and ton-miles that were transported by the various transportation modes. This information, once bridged to the IMPLAN sectoring scheme, allows us to calculate a set of county-county impedances for each commodity by weighting each of the ORNL mode-specific county-county impedances by the proportion of that commodity's travel (by value) that is achieved by each of mode.

Let's look at the trade of oilseeds from Washington County, MN to Independence County, AR as an example. According to the CFS, oilseeds are shipped 78.15% by truck, 21.76% by rail, and 0.09% by water (Table 1). The impedances between the two counties are shown in Table 2. Notice that the ORNL mixed-mode impedance between these two counties, which does not vary by commodity, is 397.8. Using the information in Tables 1 and 2 to calculate a mixed-mode impedance specifically for oilseeds between these two counties yields an impedance of 806.7. This very high impedance is an artifact of there being no water route between the two counties (reflected by the water index of 99999.9) and would limit virtually all trade of oilseeds between the two counties. To get around this, we use a water index of 1.2 times the ORNL mixed-mode index in place of the 99999.9 – we choose a factor slightly greater than 1.0 to ensure that getting between the two counties is harder than if there were a water route between them, but not so hard that there is no trade at all. Using this adjustment, we get an oilseed-specific mixed-mode impedance of 717.13. This is much higher than the ORNL mixed-mode index (which pays no mind to the fact that oilseeds are not transported by water in large amounts) and thus correctly reflects a greater cost of transporting oilseeds between the two counties. Yet it is not so high that all trade between the two counties disappears. In this way, we calculate a commodity-specific mixed-mode impedance for all commodities and for all county-county pairs.

Table 1. Transportation Mix for Oilseeds (2010 CFS)

Transportation Mode	Truck	Rail	Water
Proportion of Trade Value	0.7815	0.2176	0.0009

Table 2. ORNL Impedances from Washington County, MN to Independence County, AR

From County	**To County**	**Highway Index**	**Rail Index**	**Water Index**	**Mixed-Mode Index**
Washington	Independence	792.4	447.8	99999.9	397.8

Calibrator for Residentiary Services

The gravity model is based on Newton's Law of Gravity, whereby the force between two masses is a function of the size of the masses and the distance between them. For each commodity, the "force" is trade of that commodity between the two regions, the "masses" are the supply of the exporting county and demand in the importing county, and the "distance" is the ORNL impedances discussed in the Introduction. In Newton's Law of Gravity, distance has a constant exponent of two; however, when modeling trade, distance will have a varying influence depending on the commodity being traded. For example, the shipment of bulky or heavy commodities is generally more costly than the shipment of smaller or lighter commodities. Thus, distance will generally have a larger impact on the trade of bulky or heavy commodities than their smaller and lighter counterparts. To account for this, in IMPLAN's gravity model, "distance" has an exponent that varies by commodity.

How does IMPLAN determine which exponent to use for each commodity? For this we rely on the CFS Table "Shipment Characteristics by Two-Digit Commodity for the United States" which reports the value, tons, and total ton-miles moved by commodity. Dividing ton-miles by tons for a commodity yields the average distance travelled by each ton of that commodity, which serves as the target for calibration – *b* is adjusted for each commodity until the average distance travelled by each ton of that commodity for that commodity (for all *i* and *j*) are within ten percent the national average distance travelled by that commodity as reported by the most recent CFS.

We start the calibration process by setting *b* to the calibrated value from the previous year and solving the doubly-constrained model as:

$$T_{ij} = A_i B_j O_i D_j d_{ij} b$$

If the average ton-miles exceeds the target from the CFS by more than ten percent, b is increased, thereby increasing the importance of distance between i and j and decreasing the distance travelled. Conversely, if the average ton-miles is more than ten percent below the target value, b is decreased. This is done iteratively until the average ton-miles traveled by the commodity (across all counties) is within ten percent of what the CFS reports as the national average movement of that commodity, so long as the supplies and demands can be balanced. There are some cases where, in order to balance the supplies and demands, the calculated average ton-miles moved must differ from the average ton-miles moved reported by CFS. However, the CFS covers shippable commodities only; there is no inventory of trade flows for services. Thus, there is currently no calibration process for service flows; the *b*'s are set using analyst judgment.

Thus, we use county-to-county commuter counts from the Census to calculate a single commuter-weighted average highway impedence. We use a commuter-weighted average highway impedence as opposed to a commuter-weighted average highway distance to account for the fact that it may be more costly to drive one mile between some county pairs than others due to traffic congestion, highway tolls, etc. We then use this commuter-weighted impedence as a benchmark against the trade-weighted average impedence from the gravity model. As with the shippable commodities, we then adjust b until the commuter-weighted impedence and the trade-weighted average impedence from the gravity model are within ten percent of one another.

We use this process for what we term "residential" services only. These services are those that we expect to be consumed relatively close to the consumer's place of residence. Some examples of residentiary services are retail services (with the exception of the non-store retail sector, which includes Internet stores), car washes, child daycare services, automotive repair and maintenance, and water and sewerage services.

Results

Commodity-Specific Multi-Modal Impedances

Water transportation has a large cost advantage over railroad and highway. Thus, if the ORNL least-cost mixed-mode method is used and there is a water connection between two regions, commodities will find it easy to travel down that waterway – i.e., there will be a high level of trade of all commodities between the two regions, all else equal. This is reflected in Figure 1, which shows the exports of IMPLAN Commodity 3001 (Oilseeds) from Washington County, MN. You can see that Washington County (in red) exports oilseeds to counties all along the Mississippi River, down through Arkansas and Louisiana.

However, according to the CFS, oilseeds are shipped mainly by truck and rail, with very few shipments by water, as shown in Table 1. If the commodity uses very little water transportation in its distribution, the new mixed method will (more accurately) restrict the water "dominance". As shown in Figure 2, many of the Mississippi River counties have disappeared as trade partners under the new commodity-specific mixed mode, which reflects the fact that oilseeds travel more by highway than water. This also agrees with the highway map in Figure 3, which shows that there is no direct highway route between Washington County, MN (which is in the very near vicinity of Minneapolis) and other counties south along the Mississippi River.

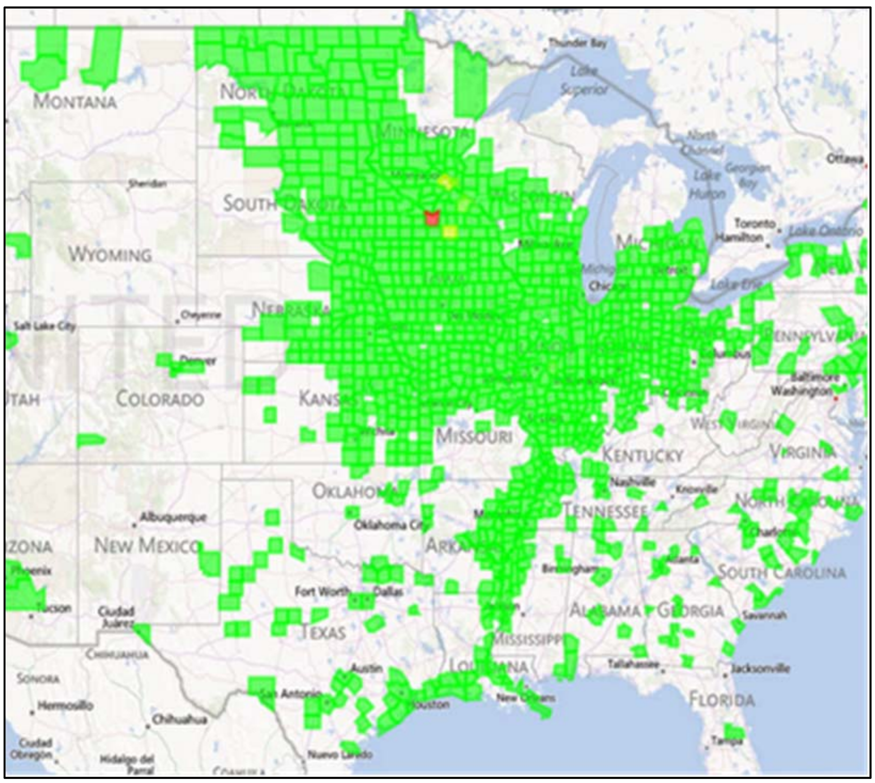

Figure 1. 2011 Exports of Oilseeds from Washington County, MN using Single Mixed-Mode Impedance from ORNL

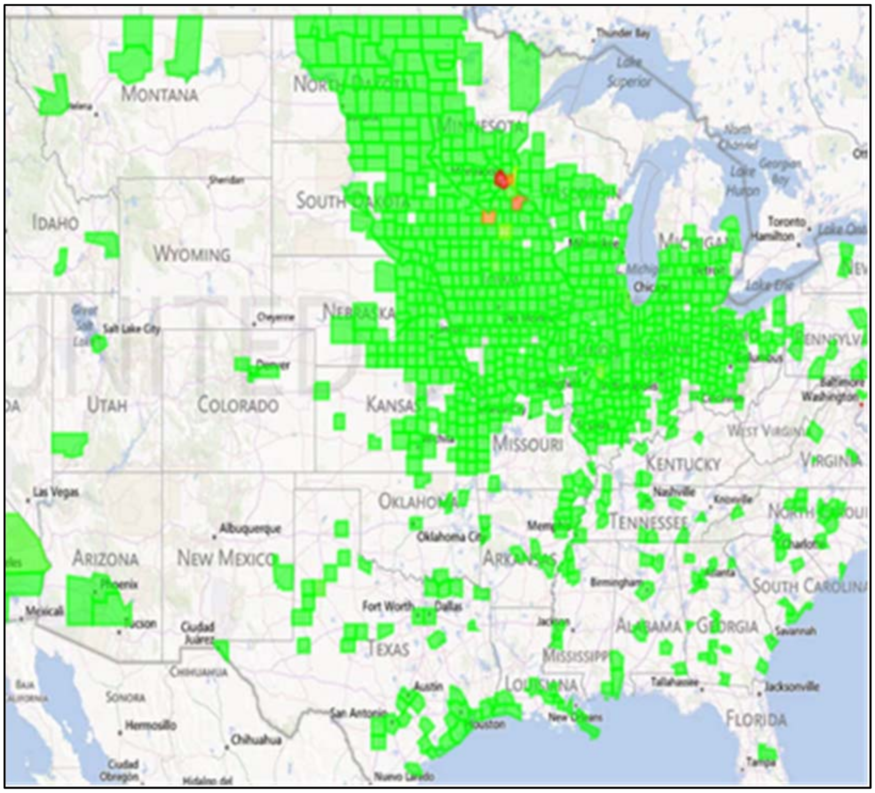

Figure 2. 2011 Exports of Oilseeds from Washington County, MN using New Commodity-Specific Mixed-Mode Impedance

Figure 3. Lack of a Direct Highway Route between Washington County, MN and other Counties along the Mississippi River

Using the original ORNL mixed-mode impedances, $5,232 worth of Washington County's oilseed production was used within the county itself, with the rest being exported. Using the new commodity-specific mixed-mode impedances, $157,287 worth of Washington County's oilseed production was used within the county itself. Thus, the higher reliance on highway and rail transportation, which are more costly than water transportation, has reduced the amount of exports of this commodity, as well as compressing the trade region.

Calibrator for Residentiary Services

The maximum allowed b in the gravity model is 8.5 – beyond this value, the model has difficulty closing and nonsensical figures are reported. Upon incorporating the new commuter impedance calibrator, b increased to 8.5 for nearly every residentiary service commodity. This suggests that the average commuter distance is shorter than the average intra-county distance.

We had expected a higher beta to result in more intra-county trade and less inter-county trade. However, distance is only part of the equation – the gravity model must also balance supplies and demands for the commodity. Thus, if a county demands more of a residentiary service than is supplied in the county, there will have to be imports of that service into the county, even if the distance between the importing county and the supplying county is greater than the average commuter distance. Indeed, we saw little change in intra-county trade but we did see a shrinking of the size of the inter-county trade region, as shown in Figures 4 and 5, which show the exports of Agricultural and Forestry Support Services (IMPLAN Commodity 3019) from Washington County, MN (the red county in the figure). While the intra-county trade remained roughly constant, the size of the trade area has shrunk after incorporating the new calibrator.

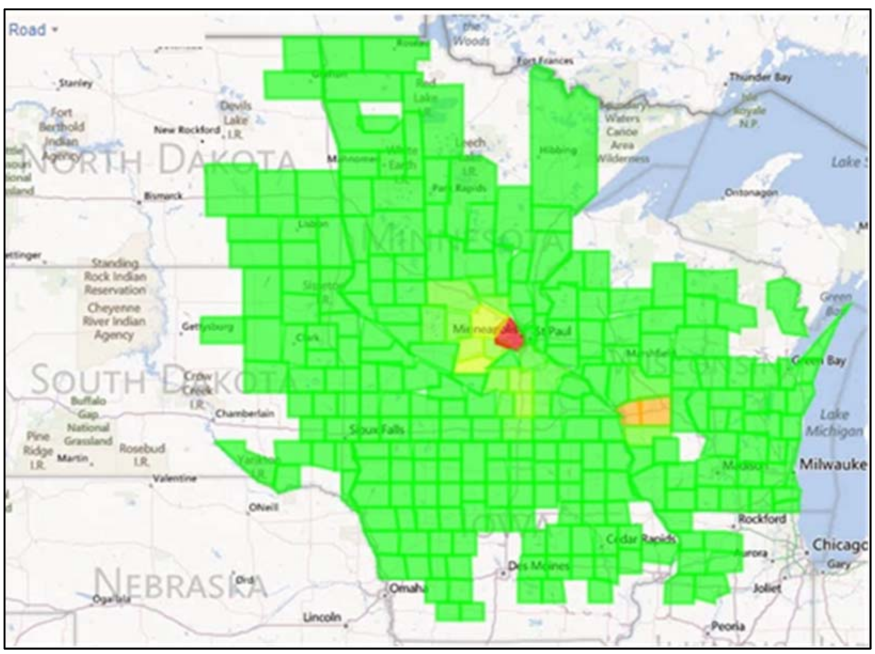

Figure 4. 2011 Exports of Agricultural and Forestry Support Services from Washington County, MN without a Residentiary Services Calibrator

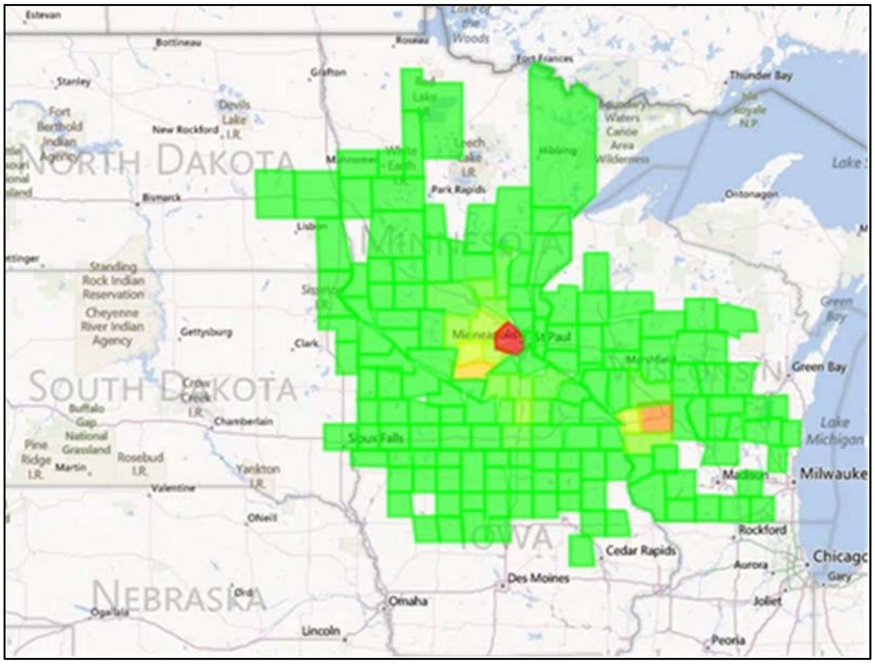

Figure 5. 2011 Exports of Agricultural and Forestry Support Services from Washington County, MN with a Residentiary Services Calibrator

The introduction of the calibrator for residentiary services seems to have had relatively minor effects on the tradeflow estimates, with trade patterns remaining very similar for most residentiary services, if slightly compressed in some cases. Generally speaking, this indicates that the betas originally chosen by analyst judgment were reasonable. However, there remains a problematic residentiary service that was not improved by the introduction of the commuting calibrator – namely, child daycare services (IMPLAN Commodity 3399). There seems to be an excess of supply in some counties, predominantly in the eastern U.S., while there seems to be an excess of demand in other counties, predominantly in the western U.S., with the effect of some fairly long trade distances of child daycare services. For instance, while Denver County, CO's exports of child daycare services are limited to the Denver Metro area (Figure 7), its imports of child daycare services come from as far away as Maine (Figure 8)! This was true before and after the inclusion of the commuter calibrator.

Figure 6. Exports of Child Daycare Services from Denver County in 2011

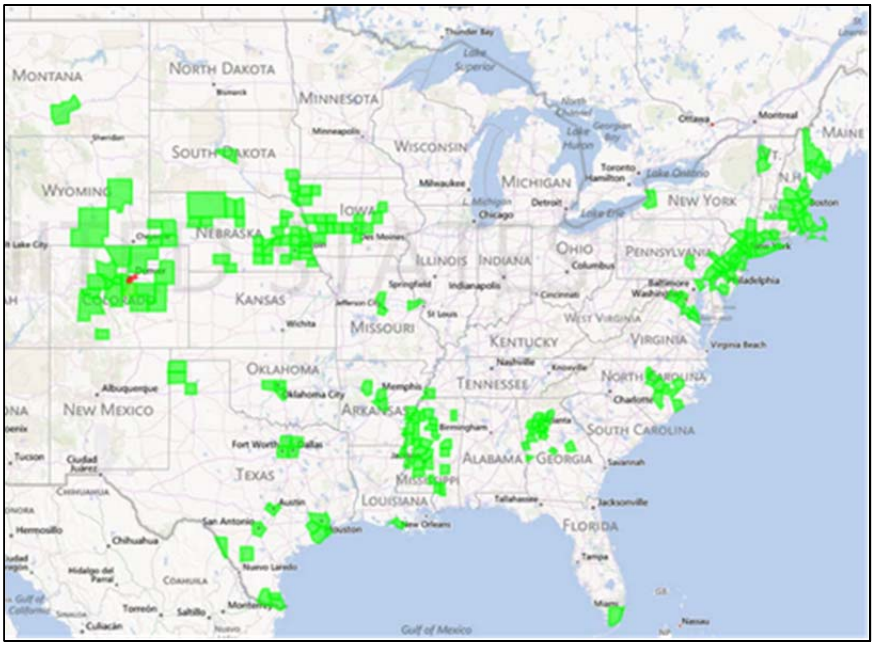

Figure 7. Imports of Child Daycare Services into Denver County in 2011

Conclusions and Future Research

When the CFS shows a more even spread between the three transportation modes, such as that for IMPLAN Commodity 3045 shown in Table 3, the ORNL combo mode is still appropriate – if a commodity can be shipped in a variety of ways, then it makes sense for it to travel by whatever modal mix is the least costly between two counties – which is exactly what the ORNL combo mode does. Thus, we have modified the gravity model to only use the new commodity-specific modal mix for those commodities that do not use one of the modes at all or are heavily reliant on a single transportation mode.

Table 3. Transportation Mix for Soybean Oil and Cakes and Other Oilseed Products (2010 CFS)

Transportation Mode	Truck	Rail	Water
Proportion of Trade Value	0.7055	0.2477	0.04675

The introduction of the commuter-distance calibrator had the only minor effects on the trade of residentiary services and these effects appear to be quite acceptable; thus, we have adopted this change into the gravity model. For the troublesome residentiary service sector of child daycare services, the temporary solution will be to set local demand equal to local supply. Demand is the most appropriate of the two factors to adjust because it is based off of national household spending patterns.

IMPLAN's gravity model still lacks a benchmark for non-residentiary services (such as wholesale trade, insurance carriers, and lodging), which are not expected to necessarily be provided near the consumer's place of residence. In these cases, beta is still set according to analysis judgment.

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MID-CONTINENT
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2013 MCRSA Conference Proceedings

Empirical Investigation of Determinants of the Poverty Rate

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Abstract. Most individuals seek to achieve what is known as the "American Dream". During that process however, some individuals fall short and in turn become a statistic in the poverty rate. This research project seeks to provide contemporary insights into potential causes of poverty in the United States, i.e., this study seeks to examine the relationship between poverty and certain explanatory variables. Using state-level data, the estimations indicate that the poverty rate is an increasing function of the percent of the population that is Hispanic, the percent of the population that is Black/African American, and the overall cost of living. The poverty rate is found to be a decreasing function of median household income, the percent of the population over the age of 25 with a high school diploma or higher, and the percent of the population that is age 65 and older.

Introduction

Poverty in the United States has been examined and discussed for decades. Presumably, the origins of poverty in this country are multifaceted. The level of poverty has a significant impact on the state of the economy and for that reason has drawn decades of concerns. What society accepts as the true definition of poverty will influence how society treats poverty (Yanagisawa, 2011). Does this imply that the factors that influence poverty can be controlled? Recent studies of poverty have provided many insights into why the rate continues to be a concerning issue and some even offer solutions to correcting those startling issues.

America is known as the land of opportunity, but the poverty problem persists. Is the average individual who is in poverty not seizing available opportunities? With the importance place on higher education, why is such a large percent of the overall population below the poverty line? The problem could be perpetuated based on the idea that our society treats poverty as a part of life, rather than a concern. Even though poverty is defined differently in many cultures, the concept of living below average is the same.

Background, Basic Model, and Data

The relevance of poverty to society is reflected to some degree by the burden it places on society. For example, for nearly a century, there has been a "welfare system" and accompanying "welfare bureaucracy" whose objectives ostensibly have involved the alleviation of poverty. Indeed, migrants who are "poor" have been found in a variety of studies to be attracted by a "welfare magnet," i.e., areas offering higher welfare benefits (Cebula, 1978; 1980A; 1980B).

As for the causes of poverty, there are those who have found the decision not to secure a higher level of education (Renas, 1973). Indeed, based upon Renas (1973) and more recent studies by Lee (2009), Rector and Sheffield (2011), the following eclectic reduced-form equation is to be estimated.

$$PV = a0 - a125WHD - a265YAO + a3BAA + a5HISP + a4COLI - a6MHI \quad (1)$$

These variables and the data corresponding thereto are found in Table 1.

Table 1. Variables

Variables	Name	Descriptions	Year
Dependent Variables	PV	Number of individuals below poverty as a percentage of the total population by state	2009
Independent Variables	25WHD	Percent of persons 25 years old and over who are high school graduates or more	2009
	65YAO	Percent of total population by state that is 65 years old and over	2009
	HISP	Percent of the total population by state that are of Hispanic origins	2009
	BAA	Percent of the total population by state that are Black or African American	2009
	COLI	Cost of living Index by state for 2009 with the United States equal to 1	2009
	MHI	Median household income by state	2009

Based on the aforementioned studies, within state j the poverty rate is expected to be an increasing function of the percent of the population that is Hispanic, the percent of the population that is Black/African American, and the overall cost of living. The poverty rate within state j is expected to be a decreasing function of the median household income, percent of the population over the age of 25 with a high school diploma or higher, and the percent of the population that is age 65 and older.

Analysis and findings

The greater the percent of the population that has attained a high school diploma or higher within state j, the less likely those individuals would be found in a state of poverty. These individuals are much more likely to have sufficient resources to meet what is typically acknowledged as the basic needs to live above poverty. The higher the level of education individuals are able to obtain, the greater the probability that those individuals have developed the necessary skills that would permit them to achieve their goal of the "American dream". Those skills would allow these individuals to be more competitive in the labor force. By being a competitive factor they are able to obtain better paying career, which in turn help provide the necessary essentials needed to live above what society defines as poverty.

Whether this defined level of poverty is solely based on an income component or a unanimously defined level; it is ultimately decided by society. The severity to which an individual with a high school diploma or higher affects the poverty rate within state j is ultimately determined by what is typical in state j. Despite society's definition of poverty, the aforementioned model proves that the level of education an individual attains has a significant impact on the level of poverty within state j.

The findings also indicate that the poverty rate is an increasing function of the percent of the population that is Hispanic. Why? Arguably, a large percent of the Hispanic population does not have the same opportunities offered to American citizens and for that reason migrate to the United States in search of those opportunities. Indeed, Fears-Hackett (2012) suggests that Latino students trying to achieve educational growth are faced with obstacles such as the fear of being undocumented, racial stereotyping, as well as their socioeconomic status and for those reasons struggle to accomplish educational growth (2012). She continues by adding that many of these students receive no guidance needed to graduate high school because they are the first generation to actually graduate high school (Fears-Hackett, 2012).

Based on few of the abovementioned factors such as education level obtained and being immigrants, the Hispanic population tends to be willing to accept lower wages for the same employment that a substantial percentage of American citizens will not accept. They then become the average employee that receives lower wages and live week by week attempting to survive each pay period. They fall into an almost never ending race to financial freedom but while trying to escape the sink hole of their financial burden, become the equipment that dips it deeper.

The percent of the population that is Black/African American was foreseen to have a direct relationship with the poverty rate within state j. The higher the percent of the population that is Black/African American, the more of an impact it would have on the poverty rate. Much like the Hispanic population, the Black/African American population usually forgo their education to help support their families. They are then left with the same employment opportunities as their Hispanic counterparts receiving low wages because of the level of education they were able to obtain.

The higher the percent of the population that is age 65 years and older, the lower the poverty rate. There are several reasons for this. These individuals have done their fair share of work in the labor force and have the retirement and accumulated savings to ease any financial burden they may face. There are also numerous programs offered to the elder such as discounts on medical coverage and utilities to lighten any financial pressures they may face. This income, in a sense, allows them to maintain somewhat of a comfortable life, especially at the retirement age. For that reason they are not faced with the same level of pressures to live above what is considered poverty in state j.

The overall cost of living within state j is expected to have a direct impact on the poverty rate, and this model verifies that it certainly is. When considering how far an average individual’s income could stretch, it is compare to the cost of living within that state. The higher the cost of living within state j, the less residual earnings individuals will retain to support other desires.

The expected and foreseen sign of median household income was that it would exercise a negative impact upon the poverty rate. The more income that enters a household, the less concern families will be about being a statistic in the poverty rate. In present day’s society, the level of income one is able to obtain determines to some degree their economic status in that particular society. Unfortunately, we live in a world where everything we need to survive has a price, so having the necessary income to ease the burden becomes a plus in terms of living above the define level of poverty.

Conclusion

This research seeks to provide contemporary insights into the potential causes of poverty using state level data for all selected variables. The poverty rate is directly related to the percent of the population that is Hispanic, the percent of the population that is Black/African American, and the overall cost of living. The median household income, the percent of the population over the age of 25 with a high school diploma or higher, and the percent of the population that is age 65 and older negatively impact the poverty rate.

Table 2. Empirical Results

Dependent Variable: LOG(PV)
Method: Least Squares
Included observations: 50
White (1980) heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(_25_WHD)	-1.177931	0.402603	-2.925789	0.0055
LOG(_65_YAO)	-0.186155	0.069763	-2.668387	0.0107
LOG(BAA)	0.027358	0.012247	2.233860	0.0307
LOG(COLI)	0.367015	0.135174	2.715130	0.0095
LOG(HISP)	0.042725	0.011467	3.726029	0.0006
LOG(MHI)	-1.474250	0.132381	-11.13645	0.0000
C	22.41917	1.197956	18.71452	0.0000
R-squared	0.935020	F-statistic	103.1238	
Adjusted R-squared	0.925953	Prob(F-statistic)	0.000000	

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2013 MCRSA Conference Proceedings

Industrial Composition, Local Fiscal Policy and Micropolitan Area Economic Growth

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Abstract. Various studies have analyzed the impact of economic policy, especially fiscal policy, on the economic growth of regional and local area economies. A general finding is that industrial composition has been a consistently important determinant of local economic growth as well as of regional differences in the effects of economic policy (Moore and Walkes (2010), Gabe (2003)). The influence of fiscal policy variables has been ambiguous depending, for example, on the measure of economic growth used – employment, population, firm growth, etc. This current study adds to the literature by analyzing the U.S. micropolitan areas (with populations between 10,000 and 50,000) following Davidsson and Rickman (2011). It finds that local and state fiscal policies, industrial composition, distance, and human capital have significant impacts on personal income growth in micropolitan areas.

JEL category: R11 Regional economic activity

Introduction

The role and impact of macroeconomic policy, primarily fiscal and monetary, on economic growth especially as measured by job creation has been studied extensively. The findings are mixed and controversial depending on the level of aggregation (country, region, state, county, or city) under study, among other factors. There is also the continuing debate as to whether economic growth depends on government policy variables such as tax rates or whether emphasis should be placed more on strengthening the inherent growth environment such as the quality of labor and infrastructure as well as the strategic mix of industries.

Although there have been many studies at the country or macroeconomic level, the actual function and practice of economic development - attracting new firms, creating jobs, increasing the tax base - have long been conducted at the local level. According to Malizia and Feser (1999), theories explaining local economic development in the U.S. have evolved and changed over time as a result of reality checks. For example, in the 1960s, economists contended that the aggregation economies found in metropolitan areas would guarantee growth; later, however, census data showed that nonmetropolitan areas experienced a "rural renaissance" surpassing the growth of metropolitan areas. Moreover, national recessions in the 1980s adversely affected rural areas dependent on mining and manufacturing industries; likewise, there were state-level differences in the effects of national recessions. As Malizia and Feser point out: "Thus, as a general rule, it appears that simplified ideas and explanations of urban and regional development prove largely incorrect by the time they take hold in people's minds. The spatial mosaic of growth and decline will undoubtedly continue to defy conventional explanations" (1999, p. 7).

This study focuses on the disaggregated geographical unit called the micropolitan statistical area. This area was defined by the Office of Management and Budget in 2003 to refer to an urban area with a population of 10,000 to 49,999. It has been the subject of relatively few studies (see Davidsson and Rickman (2011) for a review).

The objectives of this study are twofold: (1) to analyze the growth of micropolitan areas in the U.S. as measured by the growth rate of real per capita income for the period 2000-2007; (2) to identify and measure the various determinants of income growth with special focus on industrial diversity and local economic policy variables. The current study reexamines Davidsson and Rickman's (2011; hereafter, D&R) study of micropolitan areas with some significant differences:

- We employ a different measure of local economic growth (real per capita income) as the dependent variable; fiscal policies have been shown to affect income more than employment or labor supply.

- We consider a different, longer, and more recent time horizon/period – 2000-2007.

- We use D&R's original data set of 511 micropolitan areas but remove four which have populations over 50,000 (Cape Girardeau, MO-IL; Manhattan, KS; Mankato-North-Mankato, MN; Palm Coast, FL).

- We use a more parsimonious model by reducing the number of explanatory variables (for example, we combined the separate industry employment shares into one industrial composition variable), by selecting a few important control variables, and then sequentially adding groups of local policy variables; D&R found that industrial composition is the most important determinant of growth.

- We compare the differential impacts of local fiscal (state vs. local/county) and monetary policy; D&R do not consider monetary or financial policy determinants of growth.

- We compare our findings with those of D&R especially relating to the results of their wage growth equation; D&R find no significant county and state fiscal policy variables, except for state spending on highways which is significant (at the 10 percent level) but has the wrong sign.

The general framework here is based on earlier economic growth models by Mofidi and Stone (1990), Abrams, Clarke, and Settle (1999), Connaughton and Madsen (2004), and Davidsson and Rickman (2011). The analysis employs a cross-sectional data set for 507 micropolitan statistical areas which was kindly provided by Davidsson and Rickman.

The remainder of the paper is organized as follows. The next section discusses the past literature, followed by the theoretical model listing the important determinants of income growth in micropolitan areas. Then the statistical procedure and empirical findings are presented. Finally, a summary and conclusions are discussed.

Theoretical and empirical background

As discussed, the body of research emphasizing the impact of fiscal and monetary policy decisions on the various levels of political subdivisions generally fails to arrive at a consensus as to its effectiveness. The conclusion of such research is heavily dependent on the measurement of growth that is used, as well as the level of data aggregation. Thus, any review of the pertinent literature is necessarily thematically diverse and often contradictory. This review of the literature is a sample of the divergent research that delves into the localized consequences of fiscal and monetary policy changes, and the resulting impact on growth as delineated by the author(s). A common undercurrent in a significant number of these studies is that the magnitude of industrial diversity in a region has a material impact on the effectiveness of policy decisions. While diversity is consistently acknowledged as a catalyst for economic growth, the interplay between successful policy implementation and the role of industrial diversity is subject to a wide variety of interpretations.

The conclusions of Izraeli and Murphy (2003) provide a good starting point for reviewing the body of literature that addresses industrial diversity and its effects. Their study, which evaluated the economic performance of seventeen states over a thirty-eight year period, found that states with a diverse industrial mix enjoy a certain degree of insulation from the damaging effects of a national recession. Their data indicates that diverse states are better protected against the cyclical unemployment resulting from recessions compared to states with a highly concentrated industrial base. States with little industrial diversification often suffer from double-digit rates of unemployment during recessionary periods. Izraeli and Murphy suggest that, while the unemployment rate in such states should not differ significantly from their diverse counterparts as the country approaches full employment, they believe that specialization should contribute to relatively higher incomes during an expansionary economic climate, thanks to the comparative advantage which results from specialization. Their findings are: (1) industrial diversity mitigates the effects of cyclical unemployment, but this relationship is only apparent when state heterogeneity can be adequately controlled, and (2) the notion that industrial concentration results in increased per capita income during times of economic prosperity is difficult to ascertain. Smith and Gibson (1998) also find industrial diversification at the state level to be beneficial during a downturn. However, their conclusion is that the strength of unique regional economic advantages greatly complements diversification, and that diversification alone may not be an effective defense against a stagnant economic climate.

Tomljanovitch's (2004) exploration of the localized effects of fiscal policy decisions provides an effective example of how industrial diversity can act as a "wild card" in determining the success of such endeavors. Tomljanovitch points out that national policy changes in reaction to deteriorating economic conditions do not have a uniform result. Despite expansionary efforts originating at the federal level that may achieve some degree of national success, regional differences in economic prosperity tend to persist. His findings are that the composition of a region's industrial base (first conditions), along with tax rates that differ significantly by state, could act as impediments to the success of national fiscal policies. When the federal government or the states themselves attempt to address economic issues through fiscal policy, any benefits tend to be short-lived. Tomljanovitch's data shows that expansionary fiscal policy changes do not have a lasting impact on future growth patterns. The results indicate that long-term growth rates return to historical averages after five years, largely because of the structural challenges posed by first conditions that are not conducive to long-run economic prosperity. Even in the case of tax increases at the state level, which may result in detrimental short-term outcomes, long-run growth rates tend to return within a few years.

Deskins and Hill (2008) concurred with Tomljanovitch's assessment. They found that over the last two decades the negative effect of localized tax increases on long-term growth virtually disappeared. This was in spite of improvements in communications technology and transportation infrastructure which greatly lessen the barriers typically encountered by firms and individuals wishing to abandon jurisdictions that choose to raise taxes. In contrast to these studies, Alm and Rogers (2010) investigated these same themes over a longer time frame, and in the process illustrated the difficulties of establishing a sustained relationship between state-level economic performance and fiscal policy decisions. Their investigation, which spanned fifty years (1947-1997), looked at a large and assorted set of fiscal variables and their relationship to changes in taxes and spending. Alm and Rogers (2010) found a very clear yet unstable connection between changes in taxation and growth, but their results were highly dependent on the set of explanatory variables and the time period under consideration. The relationship between growth and expenditure changes on the other hand is much more certain and predictable. In their conclusion, Alm and Rogers (2010) briefly touched on the challenges of building models for predicting growth based on historical data that has not been adjusted for errors and other statistical problems. They used aggressive statistical techniques in order to remedy this problem in their data set but conceded that their conclusions merit further investigation due to these complications.

Investigations into the merits of industrial diversity at the local level encounter inherent difficulties, mostly attributable to the limitations of statistical techniques, but also to the very definition of diversity used within the study. Jackson (1984) provides a succinct yet comprehensive historical overview of this dichotomy, concluding that the diversity measures commonplace at the time of the article were not adequate for use in policy decisions. While many of the limitations cited by Jackson have been lessened by modern analytical tools, industrial diversity, despite its undeniable economic influence, continues to elude a definitive measurement. In his extensive and frequently cited investigation into the industrial diversity measurement problem, Wagner (2000) postulates that the limitations of all measurements of industrial diversity are so substantial that they should never be used as the primary justification for policy decisions which have diversity and enhanced employment stability as their ends. Regardless of the difficulties such as those cited by Jackson and Wagner, the strong relationship between diversity and growth that has been established by the extant literature undoubtedly merits continued development and refinement.

Model and estimation results

This study is concerned with the determinants of per capita income growth in micropolitan statistical areas. It extends the earlier study by Davidsson and Rickman (D&R; 2011) by: (1) using D&R's original dataset and revising and adding other variables; (2) examining a different measure of local economic growth in the form of real per capita income for a more recent period 2000-2007, and comparing our findings with those of D&R's wage growth equation; (3) employing a more parsimonious model of endogenous growth; and (4) examining the differential impacts of local economic policies: state vs. county taxes; state vs. county government spending; financial and monetary variables represented by per capita banking deposits, per capita bank offices, and a state-level branching restriction index.

Our method employs hierarchical regression on a cross-sectional data set comprised of 504 micropolitan areas. The base model in this study first examines the relationship between micropolitan per capita income growth and a number of control variables: industrial composition, initial per capita income, educational attainment, distance variables, and regional dummy variables to reflect regional fixed effects. In the second step, policy variables to reflect fiscal structures and monetary or financial development are included sequentially and finally together in a full model. Thus, the general specification is:

Micropolitan income growth = f(Initial income, Industrial composition, Education, Distance, Regional dummy variables, Fiscal policy variables, Monetary variables)

Davidsson and Rickman initially started with the original 554 micropolitan areas (as defined by the Office of Management and Budget), which cover 662 counties in the 48 continental states; however, after adjusting for outliers the final set included 511 micropolitan areas. After reexamining their data, we found that four have populations exceeding 50,000; thus, we include only 507 micropolitan areas in our analysis.

Unlike Davidsson and Rickman who use separate industry sector shares as independent variables, we combine the different industry shares into a composite index of industrial diversity. As Wagner (2000) points out, diversity is a static concept illustrating the mix of industries in an area at a specific point in time. However, Kuhlman, Decker, and Wohar (2008) find that a more important determinant of economic growth is not the area's initial level of industrial diversity but whether the level or degree of diversity is increasing (or decreasing) over the relevant long-run time period. As such, we employ a "sectoral composition variable" similar to that of Abrams, Clarke, and Settle (1999):

$$COMP_{it} = \sum_{j=1}^{10} w_{ijt}\log(emp_{j,t+T}/emp_{jt})$$

where wijt is the weight or share of sector *j* in a micropolitan area *i*'s employment at time *t*, and emp is the national average of micropolitan area employment that exists in sector *j* at time *t*. This composite variable not only reflects the industry employment shares within an area, but also shows the growth rate of employment in the area if each sector grew at the same national average rate for that corresponding sector between years *t* and *t+T* (Abrams *et al*., p. 371). COMP is thus a weighted average of "predicted" employment from ten SIC sectors for 1990-2000: farm; mining; construction; manufacturing; transportation; retail trade; wholesale trade; finance, insurance and real estate; services; and government. It is expected that as COMP increases, i.e., the micropolitan area economy becomes more diversified as the nation, the more the area's personal income grows. Initial per capita income for 2000 is included to check for conditional convergence of micropolitan area income growth rates and is expected to be negative following the literature.

The distance variable used here is the incremental distance to the nearest metropolitan area with a population of less than 250,000 following Partridge and Rickman (2008). There are two possible causal relationships between distance and income growth. One relationship may be negative, i.e., the greater the distance from a metro area, the slower the income growth ("tyranny of distance"). This indicates that there are benefits in terms of synergy and agglomeration economies resulting from proximity of a smaller local area to a larger urban area. The second possibility is that the closer a micro area is to a metro area, the more it will lose in terms of labor supply, retail sales, and spatial competition because of the low cost of travel to the larger metro area, i.e., "tyranny of proximity" (see the New Economic Geography literature, e.g., by Fujita and Mori, 2005). The squared value of incremental distance is added to adjust for nonlinear relationships. D&R do not consider spatial correlation an issue as they "do not include metropolitan or rural counties in the sample to account for spatial spillovers because by definition metropolitan and rural areas are separate functional economic regions with likely differing growth dynamics from micropolitan areas (2011, p. 185, footnote)." Nonetheless, in this current study, we include the incremental distance variable, distance squared, and eight regional dummy variables to account for the importance of spatial proximity and regional fixed effects.

The last control variable, educational attainment or human capital, is represented by the percentage of the population in the micropolitan county area aged 25 and over who have a bachelor's degree or higher. Following past studies, it is expected that the quality of the labor resource has a positive impact on a local area's economic growth.

A major objective of the current study is to measure the differential impacts of economic policy variables. Local fiscal structures in terms of different taxes and government spending activities, both at the state and county levels, are identified and tested in the extended model. At the state-level, these variables are state per capita income tax revenues, state per capita corporate tax revenues, state per capita property tax revenues, state per capita sales tax revenues, state per capita spending on highway infrastructure, state per capita spending on hospital care, and state per capita spending on public safety, all in 1992 figures. The county-level fiscal variables include per capita county tax revenues from property and sales taxes, and per capita spending on education, highway, and public safety. For comparability and to adjust for size, these fiscal variables are divided by the respective county or state-level personal income (see Davidsson and Rickman, p. 184).

In terms of macroeconomic influences, monetary policy has been shown to affect the regional economy (Carlino et al., 2009, 2003; Owyang et al., 2008). Unlike Davidsson and Rickman, we include financial and monetary variables in the analysis. Following past studies, the variables - per capita bank deposits and per capita bank offices in the counties comprising the micropolitan area - are included to reflect the area's financial development or depth. The estimated coefficients for these banking variables are expected to be positive. Finally, we include a state-level branching restrictiveness index developed by Rice and Strahan (2010) which reflects how restrictive a particular state is to entry by out-of-state banks; a negative relationship between income growth and branching restrictions is hypothesized.

Four alternative models are estimated using cross-sectional data for 507 micropolitan areas. The dependent variable, real per capita income growth, is the average annual growth rate of micropolitan area income for 2000-2007, while all the explanatory variables are initial values for the period to account for any potential endogeneity bias. Only the initial income, per capita deposits, and per capita bank offices are converted to logarithmic form. All the policy variables are expressed as percentage shares of income, while the industrial composition variable, distance, branching index, and regional dummy variables are kept as is. We also adjust for heteroscedasticity by applying White's correction on the estimated model. As mentioned earlier, the main data set was provided by Davidsson and Rickman; other additional data are gathered from the Bureau of Economic Analysis and the U.S. Census Bureau.

Descriptive statistics of the variables are presented in Table 1. The empirical estimates of the alternative models are shown in Table 2. The base model, Model 1, regresses per capita income growth on the control variables, initial income, sector composition, education, incremental distance to nearest metro area (with 250,000 population), distance squared, and regional dummy variables. The next three models sequentially add subsets of policy variables. Model 2 adds county-level fiscal tax and spending variables to Model 1. Model 3 includes state-level fiscal variables to Model 2. Finally, Model 4 adds the monetary and financial development variables to Model 3 for the full regression. To test for relative significance or redundancy of different policy variable groups, F tests were conducted. Finally, to address any concerns regarding multicollinearity, variance inflation factors (VIF) were calculated to measure the degree of collinearity between independent variables in the model. None of the VIF scores exceeded the threshold value of 10 at which multicollinearity becomes an issue.

Table 1. Descriptive Statistics

Variable	Mean	Maximum	Minimum	Std. Dev.
Income growth rate	0.011516	0.073741	-0.01991	0.012946
Initial income	29852.39	69674.3	18061.2	4491.897
Industrial composition	-0.00494	0.053179	-0.04373	0.016807
Human capital	13.21026	36.3	5.5	4.454972
Incremental distance	47.3425	601.043	0	80.07363
County sales tax	0.003892	0.023533	0	0.004381
County property tax	0.027337	0.09937	0.00371	0.013568
County highway spending	0.007092	0.024515	0.000622	0.00394
County education spending	0.054019	0.13888	0.02926	0.013256
County safety spending	0.006324	0.021972	0.000804	0.002459
State income tax	0.020076	0.039943	0	0.010728
State corporate tax	0.003733	0.009788	0	0.002145
State property tax	0.030059	0.060725	0.010091	0.010221
State sales tax	0.02497	0.051105	0	0.008179
State highway spending	0.014228	0.039311	0.007904	0.004919
State hospital spending	0.008383	0.015885	0.00435	0.002342
State safety spending	0.01366	0.021361	0.007207	0.002824
Per capita deposits	8559.42	23331.73	3134.421	2738.353
Per capita bank offices	0.000352	0.000878	9.93E-05	0.000124
Branching index	2.534517	4	0	1.545199

Table 2. Alternative Models of Micropolitan Area Income Growth, 2000-07

Variable	Model 1	Model 2	Model 3	Model 4
Constant	0.11 (1.63)	0.04 (0.47)	0.07 (1.05)	0.11 (1.60)
Initial income	-0.01 (-1.52)	-0.004 (-0.53)	-0.007 (-1.07)	-0.006 (-0.94)
Industry composition	0.18 (5.87)***	0.17 (5.41)***	0.14 (4.94)***	0.14 (4.99)***
Education	0.02 (1.90)**	0.03 (2.11)**	0.02 (2.05)**	0.02 (1.90)**
Incremental distance	-0.00002 (-1.18)	-0.00002 (-1.36)	-0.00003 (-2.25)**	-0.00003 (2.23)**
Incremental distance squared	0.0000001 (3.52)***	0.0000001 (4.17)***	0.0000001 (3.67)***	0.0000001 (3.54)***
Region 1	-0.002 (-0.78)	0.001 (0.39)	-0.003 (-0.84)	-0.003 (-0.90)
Region 2	-0.002 (-1.56)	0.001 (0.31)	0.004 (1.47)	0.004 (1.48)
Region 3	-0.005 (-4.28)***	-0.003 (-1.82)*	-0.003 (-1.42)	-0.003 (-1.45)
Region 4	-0.003 (2.31)**	0.006 (3.21)***	-0.002 (-0.63)	-0.002 (-0.78)
Region 5	-0.002 (-1.40)	0.0001 (0.05)	-0.001 (-0.50)	-0.001 (-0.52)
Region 6	0.001 (0.53)	0.004 (1.91)**	-0.005 (-1.87)*	-0.005 (-1.79)*
Region 7	0.011 (5.35)***	0.01 (5.70)***	0.007 (2.33)**	0.007 (2.23)**
Region 8	0.014 (4.46)***	0.013 (4.61)***	0.003 (0.85)	0.003 (1.12)
County sales tax		0.08 (0.60)	0.04 (0.29)	0.03 (0.19)
County property		-0.06 (-1.33)	0.03 (0.47)	0.03 (0.44)
County education		0.11 (2.37)**	0.105 (2.36)**	0.10 (2.27)**
County highway		0.05 (0.29)	0.21 (1.05)	0.17 (0.80)
County safety		0.73 (2.87)***	0.50 (2.10)**	0.52 (2.20)**
State income tax			-0.32 (-4.46)***	-0.32 (-4.28)***
State corporate			0.13 (0.49)	0.07 (0.25)

Table 2. Alternative Models of Micropolitan Area Income Growth, 2000-07 continued				
State sales			-0.31 (-3.53)***	-0.30 (-3.41)***
State property			-0.35 (-3.17)***	-0.33 (-2.74)***
State highway			1.10 (6.68)***	1.06 (6.55)***
State hospital			0.40 (1.20)	0.46 (1.27)
State safety			0.23 (0.59)	0.19 (0.47)
Bank deposit				-0.002 (-1.12)
Bank offices				0.003 (1.61)
Branching index				0.0002 (0.35)
Adj R-squared	0.40	0.43	0.51	0.51
F-statistic	27.32 (p<0.0001)	21.81 (p<0.0001)	22.24 (p<0.0001)	20.01 (p<0.0001)
No. of observations	507	507	507	507

Note: T-statistics are in parentheses. *, **, and *** denote significance at the 0.10, 0.05, and 0.01 level, respectively.

The results of applying ordinary least squares regression with White's heteroscedasticity correction on the cross-section of 507 micropolitan areas show that the industrial composition variable has a consistently positive and statistically significant (at the 1% level) influence on area income growth. Thus, a more diverse local industrial structure (similar to the national structure) is more conducive to personal income growth in the micropolitan area. Similarly, the area's human capital or educational attainment, as measured by the percentage of the population with a bachelor's degree or higher, positively contributes to income growth and is consistent with past studies. Consistent with Partridge and Rickman's (2008) finding, the incremental distance variable has a negative and significant coefficient in Models 3 and 4, supporting the contention that remoteness is detrimental to income growth; there are also nonlinear effects as shown by the significant squared distance variable. On the other hand, the initial level of per capita income is not significant in all models, suggesting no conditional convergence of micropolitan area income growth rates during the period 2000-07 under study. Moreover, there are significant regional fixed effects especially for regions 7 (West South Central) and 8 (Rocky Mountain) which show higher income growth rates over the period relative to the base region 9 (Pacific), while region 3 (East North Central) has comparatively lower growth. Our results for the control variables are generally consistent with those of Davidsson and Rickman (2011).

In Model 2, county fiscal tax and expenditure variables are added to the control variables. The estimated results indicate that micropolitan area income growth is positively and significantly related to local county government spending on education and public safety. The estimated coefficient of county property tax has the expected negative sign but is not statistically different from zero. Our results are contrary to those of Davidsson and Rickman who find no effects of both county tax and spending activities on wage growth. Although the general absence of tax effects is consistent with Denaux (2007), our findings of significant spending effects suggest that, contrary to Denaux and Davidsson and Rickman, counties are not "too small to have power over their own growth rate (2007, p. 134)." The control variables of industrial composition, human capital, and distance continue to be important determinants.

In Model 3, the state-level fiscal variables were added with the control variables and local fiscal variables. The coefficients for the state taxes on income, sales, and property all have the hypothesized negative sign and are highly significant; corporate tax share is insignificant and has the unexpected positive sign. In terms of state government expenditures, only highway spending has a positive and significant impact on metropolitan area income growth; moreover, its estimated coefficient has the largest absolute value among all the explanatory variables, indicating that for every one percent increase in highway spending, income grows more than proportionately by 1.10 percent. This is contrary to Davidsson and Rickman who find no state-level fiscal impact except for a negative (and significant at the 10 percent level) effect of state highway expenditures on wage growth. Moreover, consistent with the Model 2 results, county spending on education and safety are significant as well as the control variables of diversity, education, and distance. Combining local and state-level fiscal variables (tax and spending) in Model 3 shows that effective fiscal policy both at the county and state-wide levels are important for economic growth; this is contrary to Denaux who finds that only state fiscal policy variables have an impact.

In the full regression Model 4, financial and monetary variables are included to compare and contrast the relative effectiveness of fiscal versus monetary policy. The per capita bank deposit variable is insignificant and has the unexpected negative sign. The bank office variable has the expected positive sign but is insignificant. Similarly, the estimated coefficient of the branching index, an indicator of the entry barriers to interstate bank branching, is not statistically different from zero. This result confirms Rice and Strahan's (2010) finding that, although the liberalization of bank expansion across states led to more banking competition and growth of credit supply, this had no impact on the demand for credit especially by small firms. Thus, constraints on the ability of businesses to access capital continue to have a depressing effect on local economic growth. Finally, the relevant fiscal variables in Model 3 are also significant in Model 4, thus confirming the relative contributions of various fiscal policies on personal income growth in the micropolitan areas. Backward stepwise regression of Model 4 and the resultant F tests show that, as a group, fiscal variables (state or county) have a significant impact on local economic growth as compared to financial or monetary factors.

Conclusions and Summary

This paper reexamines and extends Davidsson and Rickman's (2011) study of U.S. micropolitan areas (central areas with populations of 10,000 to less than 50,000 people). Using Davidsson and Rickman's original data set, we compared our empirical findings especially regarding fiscal policy effectiveness relative to per capita income growth. Although the dependent variables and time frame are different, the general model specification is the same, with some changes in the explanatory variables used. After combining Davidsson and Rickman's various industry employment shares into an industrial composition variable which reflects not only various sector weights but also change of industry mix over time (1990-2000) similar to Abrams et al. (1999), we find that the more diverse the micropolitan area's industrial structure, the more the micropolitan area income grows, consistent with past studies of industrial diversification. Our results indicate that the relative distance of a micropolitan area to a metro area with a population of less than 250,000 incurs a significant cost (in terms of diffused scale economies and synergies) to local area growth; the relationship between distance and income growth is also nonlinear.

Human capital and regional fixed effects are also consistent determinants. Finally, income growth of micropolitan areas is influenced more by fiscal policies both at state and county levels than by financial factors. This study has several implications: (1) investments in strengthening an area's competitive advantages, primarily in terms of an educated labor force and efficient highway infrastructure, are vital to local economic growth; (2) local governmental units have an important role in promoting the basic services of education and public safety; (3) state governments can effectively and judiciously use tax policy to stimulate income growth in micropolitan areas; (4) just like their metropolitan area and rural area counterparts, the inherent industrial structure of individual micropolitan areas may vary widely, horizontally, and over time; thus, focusing on economic size may not be as essential as focusing on the comparative strengths and strategic industry mix of an area (Gill and Goh, 2010). Finally, given this study's limitation of using cross-sectional analysis, an interesting extension would be to apply the methodology to pooled cross-sectional and time-series data and to analyze long-run effects.

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Rural and Urban Incomes in the US, 1986-2010

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Abstract. U.S. rural per capita income is considerably below that of urban per capita income, with no obvious convergence occurring over recent decades. Various previous models and studies, such as Harris-Todaro and urban clustering, are reviewed that attempt to explain urban-rural income differentials. An equation is specified relating rural per capita income to urban per capita income and other variables reflecting agricultural, energy mining and recreational activity, and the population age structure. OLS estimates suggest that urban income, agricultural activity and energy mining activity are significant explanators of rural income levels.

Introduction

The link between incomes in urban centers and their rural hinterlands has been one studied by various economists over the decades, especially the observation that per capita urban and rural incomes remain different over time, rather than become equal. Standard economic theory (such as given in Borjas (2008), p. 167) would argue that migration between urban and rural areas will continue until values of marginal products of labor become equal (and in turn have urban and rural wages equal each other).

Looking over the 1986-2010 period, rural per capita personal income in the US averaged $ 21,104 annually, while urban per capita income averaged considerably higher, at $ 29,005, a ratio of rural to urban income of 73 percent (see Table 1, below). Looking at the "end points" of this time series, in 1986 the ratio was 72 percent (11691/16163), while in 2010 it was 77 percent (31790/41524). In 2011 urban incomes were 32 percent higher than rural ones (Izzo (2013)). If there is any convergence occurring, it is happening very slowly. (Data sources are discussed below.)

Anderson (2012, pp. 117-120) notes that in the US wages in the North and South gradually converged over the 1880-1980 period, albeit slowly and not completely. In addition, nontransferable skills, migration costs (monetary and psychological), and other impediments might thwart wage convergence.

Harris and Todaro (1970) provided another answer for the continuing inequality, concluding that migration from (low wage) rural to (high wage) urban areas will continue until the rural wage equals the expected urban wage (the latter equal to the urban wage times the probability of finding a job in an urban area); thus an urban/rural wage differential can persist in equilibrium. While the Harris- Todaro model was initially used to describe labor markets in developing countries, their work has been used to describe labor market outcomes in the United States (e.g., Suits (1985) and Partridge and Rickman (1997)). Another model that can describe urban-rural population distributions can be found in Kung and Wang (2012), where steep urban rent gradients or low transportation ("link") costs can push residents into rural areas (p. 338).

More recently, Moretti (2012) has argued that clustering leads to innovation in certain urban centers, and the resulting "social interactions among workers tend to generate learning opportunities that enhance innovation and productivity" (p. 15) This clustering also has the effect of raising per capita incomes in certain urban areas above those of other urban areas (and rural areas) for indefinite stretches of time. Similarly, Ciccone and Hall (1996) determined that labor productivity was higher in urban areas because of agglomeration economies in large cities. On the other hand, Moretti (2013) found that cost-of-living differences explain a significant amount of geographic wage differentials.

Beyond such, rural American regional economies are often tied to extractive industries, e.g. agriculture, mining and forestry, and thus more impacted by business cycles compared to other industries (Partridge and Rickman (2006), p. 255). Over the 1979-2003 period, US poverty rates among employed persons averaged higher in rural compared to urban areas (Slack (2010)).

What these and other studies suggest is that in reality wage convergence (say, between urban and rural labor markets) may either not take place, or take place very slowly. Other researchers have examined American urban-rural income differences. In a working paper, Wu, Perloff and Golan (2004) found that in US rural areas, "taxes have smaller equalizing effects and government welfare and transfer programs have larger equalizing effects" (p. 2) compared to US urban areas.

Glasgow and Brown (2012) report that the average age of the US rural population is higher compared to its urban counterpart: looking at 2005-2009 Census data, they note that the average age of non-micropolitan residents is 41.0 years, and of micropolitan residents 38.5 years, compared to metropolitan residents of 36.0 years (p. 423). There has been some migration of retired persons from urban to rural areas (Beale (2011)) and a resultant increase in local "in-shopping" by older residents (Sofranko and Samy (2003), p. 63). Certain rural areas have seen population growth because of recreational amenities (Lasley and Hansen (2003), p. 29; Johnson and Scott (2003), p. 78). Jelavich (2010) found that US total rural income was significantly and positively impacted energy prices and agricultural prices.

Some impediments to labor market mobility might be highlighted in rural compared to urban areas. These include lack of journey to work transportation (Sheldon et al. (2002)) and lack of job training opportunities, especially in sparsely populated rural areas (Decker (2011), p. 317).

Model

Of particular interest in this paper is whether economic activity in the energy, agricultural and hospitality sectors, as well as an aging US population (with a growing retired cohort), along with urban income levels, describe significantly changes in rural per capita income over the 1986-2010 period. Based on the above discussion, an equation is specified as follows:

PCRUR = f(PCURB, PENERGY, FARMRAT, HOTELCPI, MEDAGE (1)

Where:

PCRUR = per capita personal income in nonmetropolitan ("rural") areas;

PCURB = per capita personal income in metropolitan ("urban") areas;

PENERGY = producer price index for energy (100 =2003);

FARMRAT = index of the ratio of farm income to farm expenses (100= 1990-92);

HOTELCPI = consumer price index for lodging (100 =1982-84); and

MEDAGE = median age of the US population.

Sources of data are given below, under "Data Sources." Table 1 provides means and standard deviations for the variables in Equation (1).

PCURB measures per capita person income in Metropolitan Statistical Areas (MSA), while PCRUR measures such in "nonmetropolitan" or "rural" areas. (Moretti (2013) destinguishes urban from rural areas in such a fashion.) The latter will include "exurban" counties, that is, nominally rural counties abutting MSAs, some of which have become bedroom communities to their urban neighbors (see Partridge, Ali and Olfert (2010)). Both PCURB and PCRUR include both earned income as well as nonearned income, as so are not "clean" measures of labor costs. Areas with large elderly populations, for instance, will have in turn large

Social Security and other transfer payments accruing to their residents.

FARMRAT is defined in the U.S. Department of Agriculture's Agricultural Statistics annual as a "Ratio of Index of Prices Received (1990-92=100) to Index of Prices Paid by Farmers for Commodities & Services, Interest, Taxes, and Wage Rates (1990-92=100)." As such, it is used in this study as a measure of farm profitability, i.e., as FARMRAT rises, so should farm net income.

"Eclectically," following Harris and Todaro, it is assumed that the urban wage has a positive influence on the rural wage. To the extent that increasing demand for energy resources (oil, coal, natural gas, etc.) is reflected in rising energy prices, PENERGY should also impact PCRUR positively. Rising demand for rurally based recreational activities might be reflected in a rising demand (and rising price) for hotel services. An increasingly elderly population, reflected in MEDAGE, will show up as increased transfer payments (e.g., Social Security) to rural residents; whether this raises PCRUR is not obvious, however. As noted above, FARMRAT is interpreted here as a measure of farm profitability: rising farm profits should show up as rising rural per capita income.

Table 1. Summary Statistics

VARIABLE	MEAN (STAND. DEV.)	VARIABLE	MEAN (STAND. DEV.)
PCRUR	$ 21104.40 (6353.08)	ΔPCRUR	837.458 (525.252)
PCURB	$ 29005.00 (8515.60)	ΔPCURB	1056.71 (886.547)
PENERGY	98.2680 (35.2464)	ΔPENERGY	4.32917 (11.3793)
FARMRAT	90.2400 (10.3814)	ΔFARMRAT	-1.08333 (4.67106)
HOTELCPI	221.136 (56.5606)	ΔHOTELCPI	6.91250 (9.97838)
MEDAGE	34.6760 years (1.64096)	ΔMEDAGE	0.229167 (0.08065)

Equation (1) was estimated via ordinary least squares, correcting for heteroskedasticity, using the GRETL program. Estimates of Equation (1), however, were bedeviled by serial correlation. Hence the equation was respecified as follows:

$$\Delta PCRUR = g(\Delta PCURB, \Delta PENERGY, \Delta FARMRAT, \Delta HOTELCPI, \Delta MEDAGE) \quad (2)$$

That is, variables were transformed into their respective first differences; means and averages of such are reported in Table 1. Results of these regressions are reported in Table 2.

Table 2. OLS Estimates of Equation (2)

Variable	2	2(a)	2(b)	2(c)	2(d)
constant	454.449 (5.7270)**	262.489 (3.1174)**	355.629 (4.0441)**	451.653 (7.7345)**	448.197 (8.0609)**
ΔPCURB	0.293912 (4.0934)**	0.42047 (9.4497)**	0.337845 (6.0422)**	0.302743 (3.7303)**	0.318873 (4.4627)**
ΔPENERGY	10.3216 (1.6461)		11.7245 (2.0755)*	13.8961 (1.9365)*	13.9886 (2.1093)**
ΔFARMRAT	24.5627 (3.2134)**	24.5898 (4.1740)**	18.7499 (2.4499)**	24.4322 (2.7308)**	22.4900 (2.9102)**
ΔHOTELCPI	4.87517 (0.7442)	1.92883 (0.4109)		1.15845 (0.1834)	
ΔMEDAGE	-158.704 (-0.3924)	565.687 (1.5262)	325.892 (0.8502)		
R-squared	0.996038	0.964388	0.989585	0.976225	0.980674
F	905.132	128.6329	451.3146	195.0431	338.2895
DW	1.791486	1.653349	1.723750	1.804012	1.817297

*=significant at 10 %; **=significant at 5%.

Results of OLS estimation of Equation (2), again corrected for heteroskedasticity, are given in the first column of Table 2. Of the exogenous variables, only ΔPCURB and ΔFARMRAT are significant; ΔMEDAGE is insignificant but of the wrong sign, while all the other variables are of the a priori expected (positive) sign.

Multicollinearity might be cause of the insignificant coefficients, particularly given the high correlations between PCURB and PENERGY (0.7245) and PCURB and HOTELCPI (0.7621). To “correct” for this, Equation (2) was reestimated by dropping PENERGY, HOTELCPI and MEDAGE; these results are reported in columns 2(a) to 2(d). This led to the PENERGY coefficient becoming significantly positive. While PCURB and FARMRAT coefficients remained significantly positive, the coefficients for HOTELCPI and MEDAGE remained insignificant, although MEDAGE’s coefficients changed from negative to (a priori expected) positive values. One reason for insignificance could be that HOTELCPI and MEDAGE might be poor descriptors of their intended measurements (recreation/amenities and population age distribution, respectively).

Conclusions

Rural per capita income appears to be significantly related to urban per capita income, as well as farm profitability and energy prices, the latter two reflecting “extractive” industries in rural areas. Overall, however, rural income may not be that much impacted by age distribution and resulting transfer payments or recreational and amenity activities (although as noted above there may be problems with variables used to proxy such). Improving access to job training and improved commuting transportation options might be (partial) solutions to reducing the urban-rural income gap.

Data Sources

PCURB and PCRUR are from the regional data section at the Bureau of Economic Analysis’ web site (www.bea.gov/regional), Table CA1-3. FARMRAT is from the United States Department of Agriculture, Agricultural Statistics, various years. MEDAGE is from the Bureau of the Census’ Statistical Abstract, Population section, various years (available at www.census.gov). HOTELCPI is from the Bureau of

Labor Statistics' CPI measure, "Other lodging away from homes, including hotels and motels," Series ID CUSR0000SEHB02 (available at www.bls.gov). PENERGY is from the BLS' Producer Price Index measure, "finished energy goods," Series WPUSOP3510 (also available at www.bls.gov).

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2013 MCRSA Conference Proceedings

Using the Local Option Sales Tax to Support Regional Development

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Introduction

Small towns in rural America are experiencing tough economic times. For many, main streets consist of empty storefronts and rundown buildings. Signs of trouble include declines in agriculture, manufacturing, retail, and service sector jobs. Continuing improvements in rural transportation makes travel to larger towns and urban America much easier for retail trade. Local officials must come to terms with their own situations and give their citizens a realistic evaluation of their town's future, realizing that some businesses will die.

To reverse the above trends, rural towns must be willing to invest in their futures by approving bonds based on a dedicated revenue stream such as raising taxes. Tax increases would provide much needed additional revenue to cities and states in addressing a host of infrastructure and service projects. The new or additional revenue could support the development of roads, water and power supplies, schools, and public transportation to enhance future economic development efforts. Rural officials need to especially understand the critical role that healthcare plays in their local economy since it is usually one of the largest employers in the community. They also should support regional economic development efforts because everyone benefits when employment expands in the region. Rural citizens and leaders must realize that progress is optional, but change is inevitable.

The recession of 2007 documents this as many municipalities and rural communities are finding it more difficult to support capital improvement projects needed to attract manufacturing and retail projects. In Mississippi, several members of the State Legislature drafted a bill (HB Bill 523) designed to give local municipalities the authority to levy a one percent local option sales tax (LOST) to support community, economic development, and other infrastructure projects in the state. Under the current law in Mississippi, a community must obtain prior approval from the state legislature before implementing a LOST tax. House Bill 523[1] would have given all municipalities the authority to put this issue on a referendum for popular vote if they so desired. Although not widely used in Mississippi, this type of tax is a major component of economic community and development in many communities across the country.

Purpose

The purpose of this paper is twofold: first, to determine the amount of revenue that a one percent tax would generate in the four-county region of Southwest Mississippi; second, to evaluate the economic and fiscal impacts of spending the revenues derived from this tax on five broad strategies (economic development, education, health care, housing, leadership) to support economic development and tourism efforts in the four-county region in 2013. The idea in this paper is based on the "Growth Center" concept, which suggests that larger towns (such as Natchez and Vicksburg, MS) could serve as the core of regional planning efforts and magnets for job creation and retention in the region.

LOST

The local option sales tax is widely used in most states in the U.S as a way to provide needed services and help grow local economies that are still trying to recover from the worst economic crisis since the "Great Depression" in the 1930s. The local option sales tax (LOST) is a special-purpose tax implemented and levied at the city or county level in some states.[2] LOSTs are often used as a means of raising funds for specific local or area projects, such as improving area streets roads, or refurbishing a community's downtown area. A local option sales tax provides cities and counties with another important tool to help create high quality, family

[1] The bill did not pass because no action was taken by the state legislature.
[2] In Mississippi, only municipalities are allowed to collect sales taxes.

supporting jobs, stimulate private investment, and increase local revenues in their communities

Regional Overview

Table 1 shows the income distribution and median household income of the four-county region in Southwest Mississippi in 2010. The region's median household income was $8,073 lower than that of the state. In Jefferson County, the difference was more than $18,000 below the state median household income of $38,718. In Adams and Claiborne counties the income differences were $12,066 and $16,794, respectively during this period. These findings are enormously important for economic development and tourism since they suggest that any efforts to generate extra momentum in these and other areas in the region must consider the disproportionate share of households and incomes in these three counties.

Table 1. Demographic and Economic Comparisons of Southwest Region Counties, Region, and Mississippi, 2010

County	Population*	Land Area(miles)**	Density Per Square**	% White	% Black	% Other	Median Household Income	Per Capita Income
Adams	32,263	460	70.10	44.3	53.8	1.9	$ 26,784	$ 17,249
Claiborne	9,568	487	19.66	85.2	14.5	0.3	21,924	12,238
Jefferson	7,726	519	14.88	14.5	84.7	0.8	20,375	12,857
Warren	48,803	587	83.19	51	46.9	2.1	40,469	22,181
4-County Region	**31,886**	**530**	**59.73**	**59.69**	**60.85**	**1.6**	**30,645**	**17,842**
Mississippi	**2,970,072**	**46,907**	**63.32**	**60**	**37.3**	**2.7**	**38,718**	**20,521**

***Population estimates were obtained from the Census 2000, Summary File 1 for Mississippi.**

****Land area and density data came from the 2000 Census for Mississippi.**

Data and Methods

Data on municipal sales tax receipts were compiled using information obtained from the Mississippi Department of Revenue for fiscal years 2001 to 2012. I developed a decision tool called "LOST calculator" to determine the amount of revenue a one percent sales tax would generate.

During this 12-year period, in each (almost 400) municipality in Mississippi, I assumed that the proposed one percent sales tax would be levied for 15 years and the revenues used by regional leaders to implement the five strategies in the paper. The revenue generated from the tax would be pledged to repay principal and interest on bonds issued to support these and other selected projects.

The tax calculator was also used to derive the amount of debt the community could borrow, given the interest rate and terms or numbers of years the tax would be levied. I also assumed that the spending to implement these economic development strategies would occur in the first three years of the 15-year life of the tax, while the amortization of the loan would occur over the entire period.

Results

This paper focused on implementing five broad strategies to reinforce and enhance economic development and tourism in the four-county region of Southwest Mississippi in 2012. The direct expenditures associated with implementing the LOST tax was derived from an Excel-based calculator designed for this purpose. The impact on businesses and local governments from implementing these strategies was analyzed using IMPLAN's Input-Output Model. The increased sales tax revenue and resulting bond issuance and spending would provide a much needed financial injection into the local economy. The following sections look at the impact of spending on employment, sales, income, and tax revenues using the different strategies.

Fiscal Impacts

The next section shows how much revenue a one percent local option sales tax would produce in the four-county region of Southwest Mississippi in 2012. In order to determine how much revenue this tax would generate, several pieces of data were obtained. First, a baseline was determined for each municipality receiving retail sales taxes during this period. Second, using a statewide average seven percent sales tax rate in Mississippi, the amount of tax revenue that would be generated from the one percent tax was determined. Table 2 shows the estimated local option sales tax collections for the largest (or county seat) municipality in each of the four counties in Southwest Mississippi in 2012. The implementation of this tax would produce almost $10.13 million annually in the four-county region of Southwest Mississippi. Of this, $150,567, $3.99 million, $187,944, and $5.79 million in sales tax collections would occur in Fayette, Natchez, Port Gibson, and Vicksburg, Mississippi, respectively in 2012. Using an interest rate of four percent and a payment period of 15 years, I estimated that the one percent tax would allow for the combined borrowing of $92.26 million to support community and economic development efforts in the four-county region.

However, several studies suggest that implementing a local option sales tax will likely reduce retail sales in the region. This occurs because a portion of consumers' budget will now go toward paying the additional one percent sales tax rather than to purchasing additional merchandise. I assumed that a one percent increase in the sales tax rate would produce a 2.7 percent reduction in taxable retail sales and is reflected in Table 3. Even if overall retail sales in the Southwest Region declined by 2.7 percent with the imposition of the one percent local option sales tax, the four largest municipalities in the region would still have more money to support community and economic development projects than before the tax.

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3 Tax generation formula is derived from Excel Spreadsheet.
4 These communities represent the county seat of the four counties in Southwest Mississippi.
5 The formula for deriving the amount each county in the region could borrow was obtained from the Excel Spreadsheet software.

Table 2. Estimated Tax Revenues from One Percent Local Option Sales Tax.

County	City	Tax Revenue	Maximum Amount to Borrow
Adams	Natchez	$ 3,998,103	$ 36,414,378
Claiborne	Port Gibson	187,944	1,711,776
Jefferson	Fayette	150,567	1,371,352
Warren	Vicksburg	5,793,291	52,764,800
Total Region		$ 10,129,905	$ 92,262,307

Note: Figures in Table 2 reflect the 2.7% reduction in retail sales.

Economic Impacts

Using the data in Table 2, I took the revenue derived from the one percent local option sales tax and simulated the economic impact of spending those funds on community and economic development projects in the region. The other data for this analysis came from the Minnesota IMPLAN Group for Mississippi counties for 2011, the most recent year for which the relevant data were available at the time of this analysis. I assumed that the proposed one percent sales tax would be levied for 15 years and would be used by leaders in the four-county region to implement selected projects in each of the five strategies in the paper. Revenues derived from the tax would be pledged to repay principal and interest on bonds issued for various projects.

Each scenario looked at the impact of a general increase in public sector spending based on the five strategies outlined in the paper, which are economic development, education, health care, housing, and leadership. I then allocated the revenues derived from the one percent local option tax among the five strategies, a community and economic development endowment fund (C&EDEF), and a miscellaneous and operating fund to handle rising costs over the 15-year period in the following manner:

- Economic Development 26%
- Education 18%
- Housing 18%
- Health Care 13%
- Leadership 2%
- C&EDEF 11%
- Miscellaneous operating fund 11%

Next, a specific economic, human capital, or infrastructure development project was identified to assess the economic impact in the region. Table 3 contains a list of the projects and the amount invested in each strategy. The input-output model developed for Southwest Mississippi was used to calculate the effects of each scenario on this region of the state. Results from these scenarios suggest that increasing sales tax revenue and the resulting bond issuance and spending would provide an injection into the regional economy totaling more than $101.29 million in business sales, with 1,176 jobs and increased payroll of $39.36 million in the region (Table 4). In particular, Figure 1 shows the level of job creation for each strategy selected in the paper. As you can see, while all five strategies had a positive impact on employment, investing in education impacted employment the most in the region. These results confirms what is widely known about how to grow local economies and that is, investing in education and housing pay big dividends to the community.

Table 3. Discounted Distribution of Estimated Tax Revenues from One Percent Local Option Sales Tax Revenue, 2013-2028.

County		Maximum Amount to Borrow	Project Description
Economic Development	$	24,331,430	Retail Shopping Center, manufacturing plant, and recreational development
Health Care		16,220,953	Hospital expansion
Education		16,220,953	Professional development & Salary increase
Housing		12,165,715	New housing construction
Leadership		2,027,619	Training
C&EDF		10,138,096	To support community projects and existing businesses, and entrepreneurial development
Miscellaneous Operating Fund	$	11,157,543	To handle increases in cost of materials over time
Total	$	92,262,309	

Note: Revenues were discounted over the 15-year period to account for inflation and loss of purchasing power.

Figure 1. Employment Impact of Selected Economic Development Projects in Southwest Mississippi.

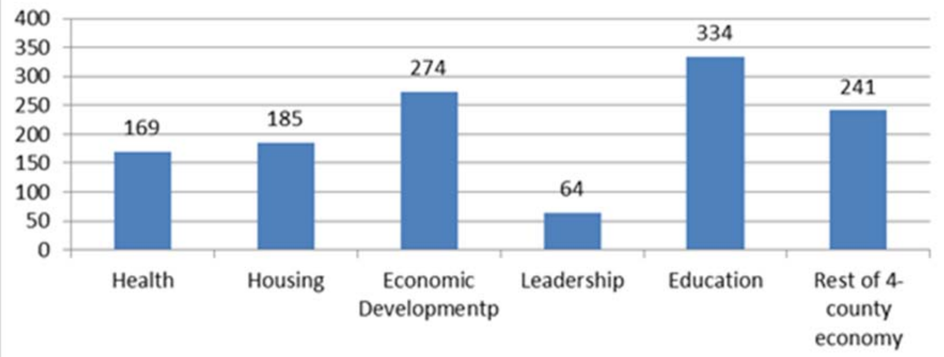

Table 4. Economic Impact of One Percent Local Option Sales Tax on Selected Programs in the Four-County Region of Southwest Mississippi, 2012

Program	Employment	Employee Compensation	Output	Local and State taxes
Health	169	$ 6,163,213	$ 17,842,652	
Housing	94	2,902,695	13,382,286	
Economic Development	274	7,786,243	12,853,726	
Leadership	64	1,320,166	2,545,273	
Education	334	13,704,009	17,842,653	
Rest of Four-County Economy	241	7,482,805	39,352,698	
Total	1,175.8	39,359,131	103,819,289	$ 4,897,533

The number of housing units that could be built with an investment of $12.17 million was obtained by dividing the initial investment by the median house value in the region ($80,920) [3].

This suggested that about 155 new houses could be built with this level of investment. The savings realized by residents of the housing construction totaled almost $14.25 million. This was derived by multiplying the number of housing units to be built times the region's median income ($30,645) times the percent of rent paid by federal housing supplements (30%). These data produced an economic impact of 91 jobs, salaries and wages exceeding $2.75 million, and about $591,633 in local and state taxes (Table 5).

[3] Median house value in each county was obtained from the 2000 Census for Mississippi and updated to 2012.

Table 5. Economic Impact of Household Savings From Housing Development in Four-County Region of Southwest Mississippi, 2012

Total Effect	Employment	Employee Compensation	Output	Local and State Taxes
	91.0	2,755,255	14,249,925	$ 591,633

In addition to the direct construction and household spending associated with housing, there are ongoing annual local impacts that result when new homes are occupied. The additional economic impact of living in affordable housing is significant since low-to-moderate households spend less on housing when living in subsidized housing. Because households typically support the local economy through consumer spending regardless of the housing type in which they reside, the marginal impacts of this strategy was also included in the paper. The report also describes the impacts of increased purchasing power of low-to-moderate households in the four-county region who are living in subsidized housing. Not only do these families realize the benefits of residing in permanent, quality, affordable housing, but also they contribute to growing the local economy through their additional spending power each year.

The impact on regional and state taxes equaled $5.49 million. Of this, about $2.20 million in tax revenues would remain within the four-county region to reinvest in additional activities and projects. I found that public spending invested in these five program areas were far more effective job creators than spending on general government services.

Multipliers

Table 6 contains the impact multipliers associated with a one percent local option sales tax in the four-county region of Southwest Mississippi in 2012. Economic multipliers are tabulated for output or gross sales, employment, and labor income. The total multiplier impacts associated with LOST are an aggregation of direct effects, indirect effects, and induced effects in the model.

Table 6. Economic Impact Multipliers Associated with a One Percent Local Option Sales Tax in Southwest Mississippi, 2012.

Impact Type	Total Multiplier
Employment	1.29
Income	1.28
Output	1.44

An output multiplier (or spending multiplier) of 1.44 suggests that for every $100 of local sales tax revenues, an additional $.44 is generated indirectly by other sectors of the economy. Similarly, an employment multiplier of 1.29 suggests that for each 100 jobs created, an additional 29 jobs are generated. Multipliers for local option sales tax ranged from 1.28 to 1.44 in the Southwest Regional of Mississippi in 2012.

Return on Investment

In addition to economic and fiscal impacts, I computed the return on public investment (ROI) which compares the level of local public investment from the tax increase to the amount of estimated local fiscal benefits measured in terms of taxes generated by each of the development strategies. The paper includes two different approaches for calculating ROI.

The first approach (Method #1) calculated ROI by subtracting total output from direct LOST revenues and dividing by Lost revenues to produce the percentage return on LOST investments. This method produced a ROI for the four-county region of 1.47, suggesting that each dollar of LOST yielded a return of about $.47 to the regional economy in 2012. The second approach (Method #2) calculated ROI as the total economic activity[4] less direct LOST revenues, divided by LOST revenues for this region. This approach produced a ROI of 1.55 for the four-county region. These results suggest that public returns from the LOST varied from 1.47 to 1.55.

Concluding Comments

Successful community and economic development is most often driven by a common vision for the community or region that is shared by most residents. While I clearly recognizes that there are many similar and yet different strategies than those outlined in the paper, these highlight the potential economic benefits of pursuing a diverse development strategy. The revenues derived from a local option sales tax could create positive economic impacts because of the additional infusion of borrowed money into local and regional economies. However, these impacts will diminish over time to account for the negative economic impact from the payment of interest on the borrowed funds du ring the planning period.

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[4] Total economic activity equals the sum of output and all tax revenues (local, state, and federal).

MID-CONTINENT REGIONAL SCIENCE ASSOCIATION

2013 MCRSA Conference Proceedings

Evaluating the Sioux Falls Business Index as an Indicator of Current and Future Economic Conditions

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Abstract. Data for the "Sioux Falls Business Index," a set of diffusion indices based on survey question responses,has been gathered monthly since 2005. In this paper we evaluate the extent to which the data provides a useful summary of both current and future economic conditions in the Sioux Falls, South Dakota, MSA by comparing the responses to monthly employment, sales, and unemployment data for the MSA. In addition to a general summary analysis of correlations for monthly and six-month intervals, the paper examines the explanatory power of the indices beyond simple autoregressive models and evaluates the predictive power of individual firm responses.

Numerous surveys of businesses have been implemented to provide timely snapshots of the state of the economy, national or regional, and potential leading indicators of future economic conditions. Manufacturing surveys from the Institute of Supply Managers (ISM) and the Federal Reserve Banks of Philadelphia, Richmond, and Dallas are regularly used to assess economic conditions. A survey of firms in the Sioux Falls, South Dakota, MSA was modeled after existing surveys and implemented in 2005 with the goal of providing economic information for the much smaller MSA region.

This paper provides an assessment of the extent to which the data provides a useful summary of both current and future economic conditions in the Sioux Falls MSA by comparing the responses to monthly employment, sales, and unemployment data for the MSA. After discussing the nature of the survey and briefly summarizing selected studies evaluating similar surveys, we explore the correlation between the various survey measures and measures of the Sioux Falls economy. In addition to assessing measures derived from pooling survey responses, the paper will also examine individual firm responses.

The Sioux Falls Business Index

The Sioux Falls Business Index (SFBI) is a set of diffusion indices derived from a monthly survey primarily of Sioux Falls businesses. The survey was begun in February of 2005 after the Sioux Falls Business Journal, a publication of the local Argus Leader newspaper, approached faculty and administrators at Augustana College to discuss creating an index of local business activity. A mailing list provided by the Chamber of Commerce provided contacts for the initial outreach, which generated first-month participation of 48 firms.

Participation in the survey is completely voluntary and varies from month to month. The monthly SFBI begins with a mid-month email to the list of interested participants. Participants are invited to go to a website designed and run by Mr. Donovan DeJong of Augustana College. After providing their passwords, participants answer a set of questions (see Appendix for the full text of the questions). They are initially asked to provide their sector and approximate number of employees and are then asked a series of eleven questions to which they may answer up, same, down, or N/A. Firms are also allowed to simply leave questions unanswered if desired. In the compilation of results, N/A and no response are both coded as missing values.

The first three questions relate to forecasting six months into the future. Participants are asked to project general conditions in the area, conditions at their specific firm, and the price level. The next eight questions gauge month-to-month changes at the specific firm in regard to revenue, employment, average wages, average hours, price of materials, price of product, inventory, and traffic. Given the variety of types of business, the number of respondents varies somewhat by question, as not all respondents find particular questions, for example, level of inventory, applicable. A set of five manufacturing-specific questions is also asked, but given the relatively small number of manufacturers in the group of respondents, answers to the manufacturing-specific questions are not reported or analyzed.

Diffusion indices of the eleven questions are computed monthly, and the resulting numbers are forwarded to the Business Journal. The Journal typically chooses two or three indices to publish in the *Vital Signs* section of their weekly publication. The *Vital Signs* are available both in print and online.

Evaluating Survey Indices

A number of assessments of the accuracy and forecasting value of survey indices have been conducted, typically focused on manufacturing surveys at the national or regional level. The survey types are similar to the SFBI, which was in fact modeled after selected Federal Reserve Bank surveys, in that they ask a series of questions with qualitative responses which are then summarized by diffusion indices. A brief summary of a few of the assessments will be sufficient to illustrate how surveys have been evaluated in the past.

Trebing (1998) examines the Philadelphia Fed's Business Outlook Survey performance from 1968 to 1998. Trebing provides an excellent discussion of a number of concerns about survey-based indices, including seasonality and respondent perception of what constitutes a 'change' in the eyes of respondents. Trebing initially evaluates the survey indices through simple regression analysis between national or regional reported monthly data and the corresponding survey index. For the national data comparisons, the regression results are strongest for input prices (R2 = 0.45) and manufacturing employment (R2 = 0.34), followed by national total and manufacturing production indices (compared to the survey's current activity index) and producer finished good prices, all having R2 values between 0.2 and 0.3. Manufacturing shipments, new orders, workweek, and inventories all generated weaker fits with R2 below 0.10. District manufacturing employment had a weaker association than national manufacturing employment (R2 = 0.26), while district average workweek showed virtually no association with the survey index. Further regression modeling, which captured the marginal explanatory power of adding the survey index of current activity to an autoregressive model of monthly change in the U.S. manufacturing production index, indicated that the index added 0.14 in R2 (from 0.17 to 0.31) to an autoregressive model with just twelve lags of the U.S. index. Schiller and Trebing's (2003) update revealed correlations similar to those reported in 1998.

Keeton and Verba (2004) examines the Kansas City Fed's manufacturing employment index in comparison to actual growth in the region. Both monthly and annual growth are strongly correlated with the diffusion index, with correlation coefficients over of 0.72 and 0.94, respectively. Changes in R2 in regression models including a lag of actual employment growth indicate that the monthly model adjusted R2 is almost doubled, while the annual model sees virtually no improvement. Keeton and Verba also evaluates the forecasting value of firms' estimates of their growth over the next six months. The associated diffusion index has a strong correlation with actual growth (r = 0.8), but the marginal contribution to an autoregressive model adjusted R2 is a much lower 0.065.

Lacy (1999) evaluates the Richmond Fed's manufacturing survey. The six-month-ahead employment index, based on a three month moving average, has a stronger correlation with national than regional employment (0.21 vs. 0.04), but the workweek index is more strongly correlated at the regional level (0.55 vs. 0.39). Current-month indices are compared only to national data, with prices paid having the highest correlation (0.85) and employment having a 0.55 correlation.

Berger (2010) evaluates the Dallas Fed's manufacturing survey. Berger also employs the marginal R2 method for assessing the value of the survey index. The four indices (employment, business activity, production, and new work orders) regressed on Texas manufacturing employment added at best 0.04 to an autoregressive model, but each measure added at least 0.15 to the adjusted R2 when regressed on state manufacturing industrial production. The largest gain when using national manufacturing industrial production was 0.06 for the business activity index.

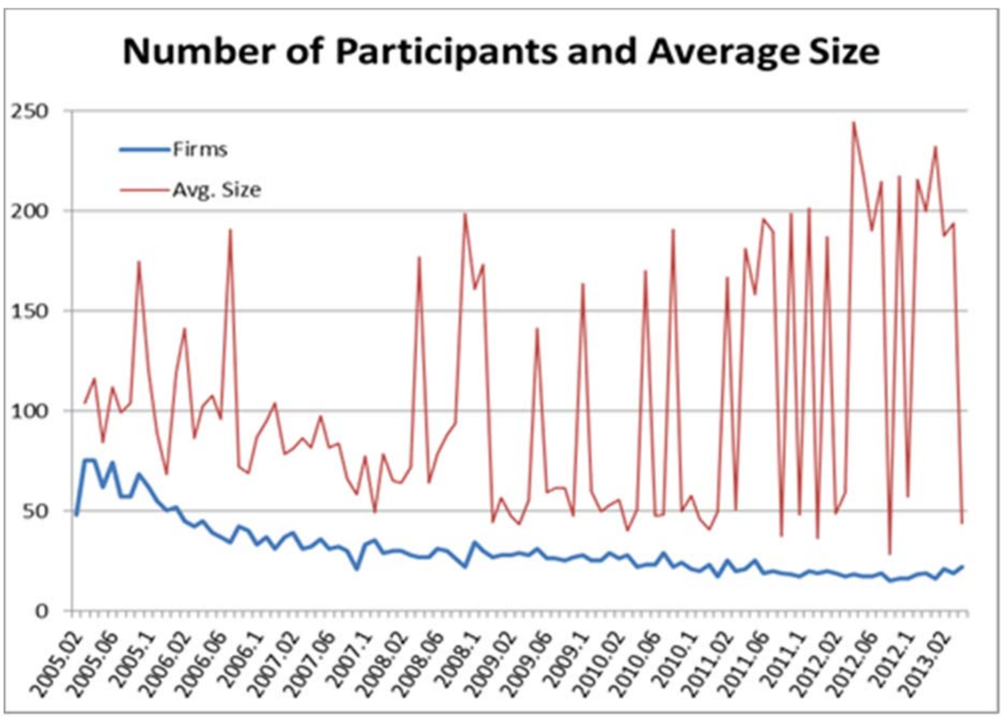
It should be emphasized that these surveys were focused specifically on the manufacturing sector and were compared to actual manufacturing outcomes. In contrast, the Sioux Falls indices are based on a variety of firms from different sectors and of different sizes and are based on a smaller number of firms with typically lower employment. As such, while it is hoped that reasonable forecasting value is found in the SFBI, it would not be surprising if the results cannot match the manufacturing surveys.

Data and Description

Sioux Falls Business Index Data

In the first month of the survey 48 responses were received, with the number rising to 75 in the next two months. Participation tapered rapidly thereafter and has declined to about twenty for the past two years. The number of participants is shown on Figure 1 along with the average firm size per month. In addition to the decline in participation, a clear tendency toward greater fluctuation in average number of employees in more recent years is evident. The respondents are from a variety of sectors and have employment ranging from one to over three thousand. A total of almost twelve thousand people were employed at the firms in the September 2005 group, for example. While a larger sample is desirable, further analysis is done on the subgroup of respondents who participated at least twenty months in order to limit variability due to inconsistent reporting.

Figure 1. Participants and average size.



For each participant, responses were converted from the up/same/down categorical response to 1, 0, and -1. Responses were averaged across participating firms to compute the equivalent of a diffusion index, but scaled between 1 and -1, rather than the -100 to 100 most commonly seen in the literature. It also differs from the index reported in the Business Journal, which is placed on a 0 to 100 scale, with 50 indicating a net neutral response.

The eleven indices computed across firms were all seasonally adjusted prior to analysis. Descriptive statistics for the seasonally-adjusted series are shown in Table 1. Every index was positive on average, with the three six-month indices and the price of materials index having higher averages than the others. Inventories has the lowest average, and average hours and traffic both have average indices of less than 0.1. The range of standard deviations is from 0.095 to 0.225, with much more volatility in the six-month-ahead MSA forecast than in any other indicator and with the average wage index volatility much lower than any other. The six-month-ahead MSA forecast ranged from around negative one-half to close to 0.6.

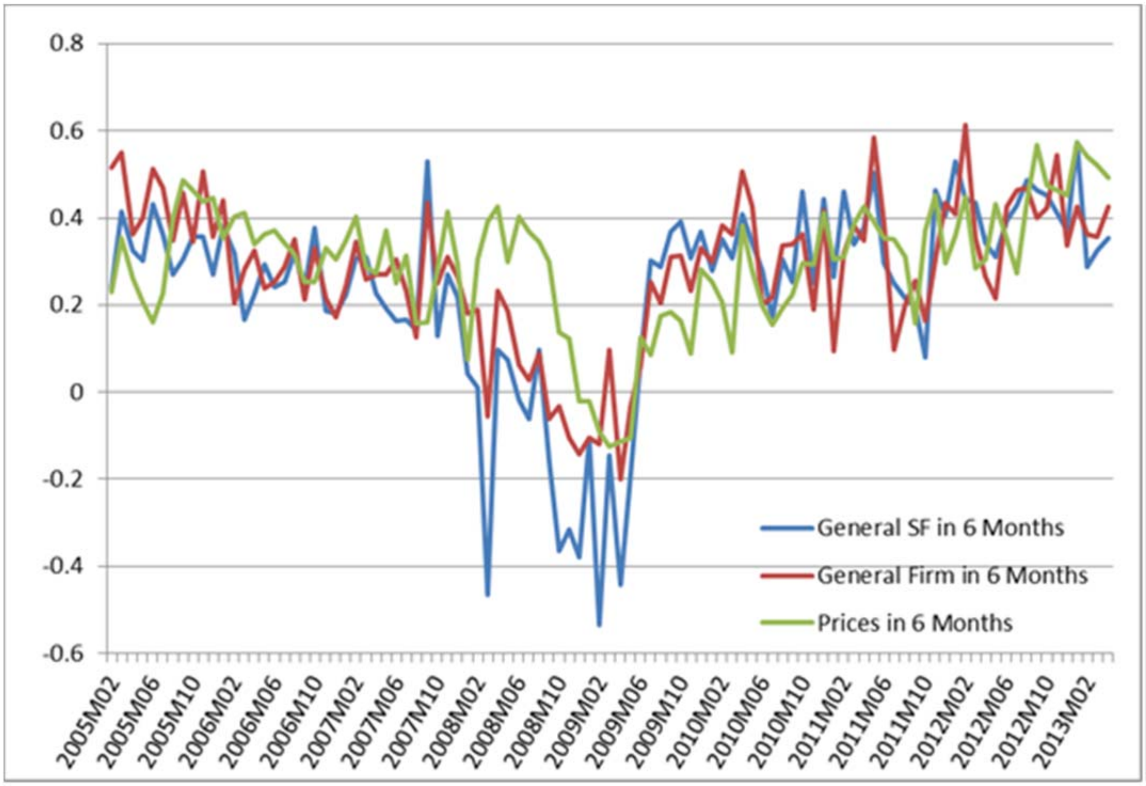
Table 1. Descriptive statistics for survey indices.

	Sioux Falls in Six Months	*Firm in Six Months*	*Prices in Six Months*	*Revenue*	*Employees*	*Avg. Hours*	*Avg. Wage*	*Price of Materials*	*Price of Product*	*Inventory*	*Traffic*
Mean	0.235	0.277	0.294	0.147	0.058	0.092	0.140	0.284	0.132	0.020	0.094
Median	0.294	0.306	0.306	0.151	0.061	0.084	0.143	0.300	0.143	0.044	0.076
Standard Dev.	0.225	0.169	0.147	0.168	0.127	0.134	0.095	0.191	0.140	0.137	0.161
Min.	-0.534	-0.199	-0.125	-0.362	-0.235	-0.216	-0.101	-0.186	-0.229	-0.361	-0.298
Max.	0.572	0.615	0.573	0.612	0.369	0.374	0.363	0.699	0.411	0.331	0.513
Count	99	99	99	99	99	99	99	99	99	99	99

The individual series are acceptable for analysis, but a single overall index was also created in anticipation of analyzing individual firms. The index, a simple average of the revenue, employment, average hours, and traffic responses, allows for finer gradations, rather than the limited -1, 0, and 1 values, when analyzing the individual firms.

The indices exhibited significant correlation among themselves. As shown in Figure 2, the six-month-ahead indices had strong co-movements for much of the time period. While all clearly shifted during 2008 and the first half of 2009, there was significant deviation among the three series in that time period as firms forecasted a worse fate for the MSA as a whole than they did for themselves and saw less impact on prices than on broader economic conditions.

Figure 2. Six-month ahead indices



Correlations among all of the indices are shown in Table 2. The six-month ahead MSA and firm measures have a correlation coefficient of close to 0.9 and share moderate correlations with the traffic index. Among the month-to-month indices, all correlations are above 0.3, with highs of 0.75 between the prices of materials and products and 0.62 between employees and average hours. The overall index variable is strongly associated with the four components used in its construction.

Table 2. Correlations among indices.

	gensf6mo	genfrm6m	price6mo	revenue	employee	avghours	avgwage	pricmatl	pricprod	inventry	traffic	index
gensf6mo	1.000											
genfrm6m	0.873	1.000										
price6mo	0.546	0.538	1.000									
revenue	0.288	0.360	0.399	1.000								
employee	0.234	0.372	0.483	0.540	1.000							
avghours	0.177	0.287	0.360	0.591	0.620	1.000						
avgwage	-0.008	0.072	0.183	0.457	0.618	0.512	1.000					
pricmatl	0.172	0.242	0.632	0.444	0.603	0.431	0.416	1.000				
pricprod	0.341	0.462	0.760	0.472	0.603	0.484	0.360	0.752	1.000			
inventry	0.275	0.375	0.385	0.420	0.456	0.333	0.324	0.364	0.438	1.000		
traffic	0.529	0.610	0.397	0.616	0.549	0.509	0.363	0.319	0.367	0.446	1.000	
index	0.384	0.502	0.494	0.853	0.800	0.810	0.580	0.535	0.575	0.503	0.827	1.000

Note: Correlation coefficient absolute values above 0.20 are statistically significant at the 0.05 level (two-tailed).
Absolute values above 0.26 are significant at the 0.01 level.

Economic Indicators

The primary economic measures compared to the indices were monthly series for employment, sales, unemployment, and the unemployment rate. Reasonable comparisons require not only monthly data, but also measures that broadly encompass economic conditions in the MSA. Both BLS employment series, the employer- and employee- based series, were considered, and we elected to use the employee-based (CPS) series, as it is also the source of the unemployment measures. The impact on our results should be minimal, since the correlation between the employment series in 0.96. Sales was investigated as an alternative measure available at the county level (with sales in Minnehaha and Lincoln Counties, the home to the city of Sioux Falls, combined). The state of South Dakota provides monthly totals of taxable sales in a timely fashion on its website, and the totals from the tabulation were considered for economic indicators. The unemployment measures were not originally considered, but earlier cursory research on the SFBI had indicated that unemployment measures may, in fact, have stronger association with the indices than do employment and sales indicators.

The economic indicators were all seasonally adjusted. Descriptive statistics for the economic indicators are shown in Table 3a, and associated changes and growth rates are shown in Table 3b. Employment in the MSA averaged about 123,000, fluctuating between 114,000 and 129,000. Unemployment averaged close to 5,000, with a low around 3,000 and a high above 7,000. The unemployment rate averaged about 3.75%, varying from 2.3% to 5.7%. Employment exhibits far less variability, relative to the average value, than the other measures.

In terms of monthly changes and growth rates, employment changes averaged about 150, but the minimum and maximum swings exceeded plus and minus one thousand, or close to a one percent swing in either direction. Unemployment had a larger maximum monthly swing, but declines were not as pronounced. The unemployment rate had one single-month increase of one percentage point.

Table 3a. Descriptive statistics for economic indicators, n = 99.

	Sioux Falls Gross Sales	*Sioux Falls MSA Employment*	*Sioux Falls MSA Unemployment*	*Sioux Falls MSA Unemployment Rate*
Mean	936698284	122599	4824	3.77
Median	922067679	123048	4983	3.78
Standard Deviation	117437886	3289	1380	1.04
Minimum	726328780	114181	2932	2.30
Maximum	1212900572	129068	7175	5.66

Table 3b. Descriptive statistics for economic indicators changes and growth rates, n=98.

	ΔSales	*Δ Employ.*	*Δ Unempl.*	*Δ Unempl. Rate*	*Sales Growth Rate*	*Empl. Growth Rate*	*Unempl. Growth Rate*	*Unempl. Rate Growth Rate*
Mean	4033399	152	6.4	0.0015	0.0055	0.0013	0.0024	0.0013
Median	-817713	175	-4.8	-0.0172	-0.0010	0.0014	-0.0016	-0.0048
Standard Deviation	43637247	537	202.8	0.1583	0.0496	0.0044	0.0453	0.0447
Minimum	-119660589	-1034	-335.0	-0.3501	-0.1414	-0.0081	-0.0859	-0.1069
Maximum	156386855	1277	1424.3	1.0347	0.2153	0.0101	0.3162	0.2953

Analysis of the Predictive Value of Survey Indices

Month-to-Month Correlations

The predictive value of the survey indices was first evaluated using simple correlations between the indices and the same-month economic indicators. The economic indicator most strongly correlated to the monthly firm indices was the unemployment rate, which had a negative correlation coefficient at or below -0.5 for employees and prices of both materials and products (Table 4). Revenue, average hours, average wages, and the constructed index all had correlations stronger than -0.35 with the unemployment rate. The unemployment change and growth indicators were also negatively correlated with all indices, but typically with correlation coefficients at least 0.2 weaker than the unemployment rate correlation coefficients with the strongest indices. Notable exceptions are the traffic and composite indices, which have stronger correlations, between -0.3 and -0.4 with the unemployment change and growth measures. All of the indices have positive correlations with change and growth in employment, but the correlations are weaker, with the strongest being about 0.25.

Table 4 also shows correlation coefficients between the indices and binary versions of the economic indicators, i.e., defining them as 1, 0, and -1 variables themselves, more consistent with the original survey data indicators. This conversion does actually strengthen the correlations between many of the indicators and the indices for employment, but the highest is still a modest 0.315, and the unemployment correlations are much weaker. The final row of Table 4 is for a modified binary measure which defined the 1, 0, and -1 categories based on thresholds slightly above and below zero growth to define the no change (0) category. This measure generated roughly equal numbers of up, down, and no change months. Correlations reveal, however, that this measure has a weaker association with all monthly indices than did the simpler binary conversion.

An additional interesting comparison involves the six-month forecasts as indicators of current-month economic activity. As shown in Table 4, the future forecasts frequently provide stronger correlations with current economic activity, as strong as -0.5 between general MSA conditions and changes in the unemployment rate. These associations suggest that survey participants may be using current general conditions, rather than firm-specific conditions, to forecast future economic activity in the MSA.

Overall, the month-to-month correlations are somewhat disappointing, falling well short of the association found in the manufacturing surveys reviewed above. As previously mentioned, given the smaller number of firms, the broad sectoral mix, and comparison to economy-wide indicators rather than sector-specific ones, weaker correlations were expected. However, typical absolute correlations in the 0.2 to 0.3 range, suggesting explanatory power under ten percent, lead to serious concerns about the information provided by the survey.

Table 4. Correlations among indices and monthly economic indicators.

	SF 6mo	*firm 6mo*	*Price 6mo*	*revenue*	*employee*	*Avg hours*	*Avg wage*	*Price matl*	*Price prod*	*traffic*	*index*
unemp_rate	0.226	0.119	-0.246	-0.351	-0.545	-0.360	-0.459	-0.591	-0.500	-0.023	-0.370
chempl	0.198	0.243	0.238	0.165	0.247	0.070	0.108	0.233	0.243	0.166	0.196
chunempl	-0.500	-0.422	-0.483	-0.199	-0.314	-0.185	-0.071	-0.302	-0.285	-0.374	-0.326
chunemprt	-0.476	-0.404	-0.467	-0.209	-0.313	-0.172	-0.088	-0.306	-0.275	-0.364	-0.323
grempl	0.198	0.245	0.234	0.172	0.251	0.069	0.109	0.234	0.242	0.171	0.201
grunempl	-0.495	-0.430	-0.451	-0.192	-0.315	-0.194	-0.057	-0.258	-0.261	-0.370	-0.325
grunemprt	-0.477	-0.418	-0.437	-0.212	-0.325	-0.187	-0.079	-0.265	-0.254	-0.364	-0.331
binchempl	0.143	0.173	0.206	0.226	0.315	0.143	0.148	0.175	0.205	0.188	0.262
binchunempl	-0.270	-0.268	-0.284	0.036	-0.157	-0.052	0.037	-0.030	-0.056	-0.236	-0.122
binchunemprt	-0.283	-0.270	-0.361	0.015	-0.154	0.000	0.087	-0.105	-0.115	-0.229	-0.112
bingremp	0.137	0.158	0.183	0.138	0.241	0.029	0.127	0.141	0.149	0.097	0.151

Note: Correlation coefficient absolute values above 0.20 are statistically significant at the 0.05 level (two-tailed).
Absolute values above 0.26 are significant at the 0.01 level.

Six-month Correlations

While the month-to-month results were somewhat disappointing, the six-month measures indicate that the survey may, in fact, be providing useful information about the economy. As shown in Table 5, a simple comparison of six-month changes and growth rates for the economic indicator with the six-month lagged indices reveals numerous moderate to strong correlations. All of the correlations are in the expected direction and are statistically significant at the 0.05 significance level, with most of them significant at the 0.01 level. The MSA and firm forecasts generate similar correlations, as expected given their correlation of 0.873, with the MSA forecast having slightly stronger association with economic indicators. As with the monthly indicators, the strongest correlations relate to unemployment, with values reaching below -0.7 for the MSA forecast, but the employment forecast has strong positive correlations of about 0.65. Associations with sales, which was omitted from the monthly table due to its low correlation with any indicator, are surprisingly strong at about 0.5 with the MSA index.

Table 5. Correlations among six-month ahead indices and economic indicators.

	Six-Month Lagged Index		
Six-Month Indicator	*General Conditions in Sioux Falls*	*General Conditions in Firm*	*Prices*
ΔSales	0.523	0.446	0.253
ΔEmployment	0.652	0.624	0.544
ΔUnemployment	-0.730	-0.696	-0.385
ΔUnemp. Rate	-0.747	-0.718	-0.418
Sales Growth	0.499	0.432	0.242
Employment Growth	0.643	0.620	0.538
Unemployment Growth	-0.694	-0.674	-0.319
Unempl. Rate Growth	-0.710	-0.692	-0.349

Note: Correlation coefficient absolute values above 0.21 are statistically significant at the 0.05 level (two-tailed). Absolute values above 0.27 are significant at the 0.01 level.

Autoregressive Models for Six-month Changes

The correlations examined in the previous section may potentially overstate the value of the indices given that other information, especially lagged values of the economic indicator itself, also provide predictive information. As noted in the review above, previous studies of indicators typically model some time series function of the economic indicator with and without the survey index to judge the marginal addition to adjusted-R2. We have done so here using the six-month ahead index for the Sioux Falls area as a whole to predict six-month changes in sales, employment, unemployment, the unemployment rate, and the employment and unemployment growth rates.

The results are illustrated in Table 6. Marginal adjusted-R2 is sizeable in each of the models; in fact, it is greater than the simple first order autoregressive model in every case. Adding the index roughly doubles the adjusted-R2 in the employment models, more than doubles it in the unemployment models, and provides almost all of the explanation in the sales model. The estimated slope on the index is highly significant in each model. The slopes can be interpreted as the effect on the associated indicator from a one unit increase, e.g., from all firms saying that economic conditions will stay the same to all firms saying that they will improve. For employment, a one unit change in the index leads to a predicted increase in employment of 3803, or a growth rate of 3.1 percent. For unemployment, such a change leads to a predicted decrease of 2745, or a decline of 66 percent, or an unemployment rate decline of 2.17 percentage points.

Table 6. Marginal adjusted R^2 by adding MSA index to autoregressive model.

Dependent Var.	*Adjusted-R^2 Without MSA Index*	*Adjusted-R^2 With MSA Index*	Marginal Adjusted-R^2 from MSA Index	MSA Index Slope	p-value
ΔSales	0.008	0.346	0.338	161900000	0
ΔEmployment	0.212	0.436	0.224	3803	0
ΔUnemployment	0.138	0.578	0.440	-2745	0
ΔUnemp. Rate	0.181	0.591	0.410	-2.17	0
Employment Growth	0.208	0.425	0.217	0.031	0
Unemployment Growth	0.132	0.525	0.393	-0.66	0

Individual Firms

The assessment of the aggregated indices provides useful insight into the value of the survey. Beyond the aggregate, though, we are also interested in the relative predictive value of individual firms, especially given fluctuating set of firms and the possible need to solicit additional participants. Interesting questions may arise as to the value of individual firms in predicting economic activity and whether or not small subsets may be sufficient for predicting economic activity.

For this initial analysis, the ten firms with the most monthly responses have been chosen, and the focus is placed on the six-month ahead MSA economic conditions and firm condition indices, the most successful indicators from the previous sections. The monthly indices were also examined, but they tended to yield relatively low correlations, as they did in the aggregate analysis, although there were notable exceptions of occasional values above 0.5 for selected firms.

The correlations between individual responses of the top ten firms and six-month change in economic activity were computed and summarized in Tables 7a and 7b, which separate out sales and employment from unemployment. While the average correlations were well below the aggregate numbers, several firms exhibited moderate correlation with future economic activity. This is perhaps more impressive when one considers that the index variables here are the more crude 1, 0, -1 values rather than continuous values generated by averaging across firms.

The firm-level correlations are summarized according to how many firms had correlations opposite expectations (positive expected for employment and sales, negative expected for unemployment) and how many had values in selected ranges of the expected sign. For sales, three firms had correlations opposite the expected sign, with one firm having a correlation of the opposite sign for employment. Five firms' MSA forecasts had correlations of above 0.2 with change in sales, while four had larger correlations with sales growth. The highest values were just over 0.4 for each indicator. Only one firm had an opposite-sign correlation for employment change and growth, and seven of the ten had correlations above 0.2, with two above 0.4 and maximum correlations around 0.56. Correlations between forecast firm conditions and sales/employment were weaker.

Table 7a. Summary of individual firm six-month ahead MSA and firm forecast correlations with employment and sales economic indicators.

	MSA Forecast					*Firm Forecast*				
	Negative	0 To -0.2	0.2 To 0.4	>0.4	Max	Negative	0 To -0.2	0.2 To 0.4	>0.4	Max
ΔSales	3	2	4	1	0.426	3	5	2	0	0.321
ΔEmployment	1	2	5	2	0.556	1	5	4	0	0.358
Sales Growth	3	3	3	1	0.402	3	6	1	0	0.302
Employment Growth	1	2	5	2	0.558	1	5	4	0	0.364

Note: Correlation coefficient absolute values above 0.21 are statistically significant at the 0.05 level (two-tailed).
Absolute values above 0.27 are significant at the 0.01 level.

With respect to unemployment, three firms' forecast MSA conditions were of the opposite sign, with fewer anomalies for the forecast firm conditions. MSA forecasts revealed several higher correlations, with four firms' forecasts having correlation coefficients above 0.4 with the unemployment rate, unemployment growth, and growth in the unemployment rate. Maximum values were between 0.5 and 0.6 for all index/indicator combinations.

Table 7b. Summary of individual firm six-month ahead MSA and firm forecast correlations with unemployment indicators.

	MSA Forecast					*Firm Forecast*				
	Positive	0 to -0.2	-0.2 to -0.4	<-0.4	Min	Positive	0 to -0.2	-0.2 to -0.4	<-0.4	Min
ΔUnemployment	3	2	2	3	-0.594	2	5	2	1	-0.544
ΔUnemp. Rate	3	2	1	4	-0.600	1	5	2	2	-0.551
Unemployment Growth	3	2	1	4	-0.537	2	4	3	1	-0.525
Unemployment Rate Growth	3	2	1	4	-0.541	2	4	3	1	-0.527

Note: Correlation coefficient absolute values above 0.21 are statistically significant at the 0.05 level (two-tailed). Absolute values above 0.27 are significant at the 0.01 level.

Conclusion

This initial evaluation of the Sioux Falls Business Index reveals a number of fascinating characteristics and associations. We find fairly small associations between monthly indices and economic activity, but we discover much larger correlations when examining six-month ahead forecasts. These correlations persist when other available economic information, in the form of lagged economic indicators, is also included in a regression model. While the strong association exhibited by the aggregate index is not matched by any individual firm, we find several strong associations. We also find that some firms' forecasts have correlations opposite what would be hoped for in an economic index.

Further research might investigate combinations of firms, or perhaps exclusions of firms with counter-intuitive correlations. Such combinations might be very informative in the process of keeping existing firms and recruiting additional firms to the sample. If sectoral or size tendencies are found to influence the predictive success of a firm, that information might be used in future sample selection.

Additional research might also expand the modeling of future growth beyond the autoregressive models used here, which were chosen for their simplicity and comparability to existing evaluative techniques. Additional lags, error term specifications, and other existing data might be employed to find best fits with and without the index variables.

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What Election Campaign Lawn Signs Indicate: Estimating Demographic Characteristics from Publically Observable Neighborhood Phenomena

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There is probably a relationship between the number of kids' toys littering yards in a neighborhood and the number of children. We don't know what that relationship is because nobody has tried to find it yet. But think how useful it would be. The school districts could easily predict the upcoming year's kindergarten enrollment. Head Start and other subsidized preschools could be orchestrated to meet the exact community needs. The park district could organize their summer offerings to respond to future demand. The housing unit method of population estimation is based on this essential idea: relating environmental characteristics (such as water or electricity hook-ups) with population (Smith 1986). In this paper I propose a similar method. Instead of total population, this method estimates characteristics of the population.

This proposal builds on the literature of neighborhood indicators led by the National Neighborhood Indicator Partnership.[1] Neighborhood indicators are data about an area that point to some quality or phenomena that is of interest to policy-makers (table 1).

National Neighborhood Indicators Partnership is an initiative of the Urban Institute. www.neighborhoodindicators.org

Table 1. Dimensions of neighborhood indicators

		Person-based		Environment-based	
		contained in individual	*individual-environment interaction*	*environment-individual interaction*	*contained in the environment*
quantitative	*open*		mode of transportation	number of front-yard gardens, lawns,	broken windows, mailboxes, windows, childrens toys, stairs, political yard signs
quantitative	*access -- free*	median age, percent race, income, family relationships	housing tenure, rent, sale price	housing characteristics -- bedrooms, bathrooms, kitchen,etc., land use and zoning	soil type, watersheds, administrative designations
quantitative	*access -- fee*	school enrollment	criminal acts	sewer, water, electricity networks and hook-ups, prostitution	contamination
quantitative	*private*	grades, drug use, recreational activities			
qualitative	*open*	appearance	qulaity of life	street activity	scents
qualitative	*access -- free*	community sentiment	culture		
qualitative	*access -- fee*				
qualitative	*private*	mental health, physical health, opinions, values	fear of environment, exposure to violence		

There are many dimensions on which neighborhood indicators fall. The first dimension is the qualitative/quantitative dimension. Qualitative indicators such as quality of life are at one end while quantitative indicators such as age, income or mailboxes are at the other end. The second dimension is the person/environment spectrum. At one end there are descriptions of individuals such as drug use or recreational activities. At the other end are descriptions of the environment such as lawns or stairs. In the middle of this spectrum there are phenomena that describe the interaction of people with their environment such as mode of transportation used to travel to work or fear of the neighborhood. The third dimension is the accessibility of the information. There are essentially three categories. The first category is information that can be observed and collected by anyone. The second category is information that requires the observer to have special access (for example through a survey or through administrative records) but that is made public either in easily accessible databases or by special request. This category can be split into two: data that is freely available and data that is available for a price. The final category is data that is private. It may be possible for to access the data but that person or group would not be able to publicize the data.

The literature that has developed around neighborhood indicators has focused primarily on collecting data about people that falls into the quantitative/special access category with the hope that this data will indicate qualitative/private characteristics of the population in small areas such as neighborhoods. Some examples of this are collecting crime data to indicate things like drug use and neighborhood safety (Furr-Holden et al. 2010). There is no established relationship between the two but the idea is that if you track these data over time and the crime rate goes down, then the neighborhood is getting safer or fewer neighborhood residents are engaging in drug use.

There is also a literature around the connection between characteristics of people and of the environment. The broken windows theory (Wilson and Kelling 1982) theorizes that there is some connection between the activities of people and the environment. This theory has been challenged based on the direction of causality and its imprecise definitions. The theory attempts to tie characteristics of the environment that are both qualitative (such as loitering) and quantitative (such as litter or broken windows) to demographic characteristics (such as fear of the environment).

Both these theories tackle a difficult problem: To relate a quantitative phenomenon to qualitative characteristics of the population.. Even if the qualitative characteristics were well defined, the relationship presents a serious measurement problem. As such it is nearly impossible to identify stable relationships. I propose a more modest goal. Our knowledge of quantifiable characteristics of the population is incomplete. Finding ways to expand that knowledge to many different geographic areas and to frequent time intervals would be an asset to policy-making and analysis.

This project proposes that there are relationships between observable, quantifiable phenomena in an environment and quantifiable characteristics of the population. It is useful to find these characteristics because individual characteristics are costly and time-consuming to collect while open, environment characteristics are much more easily and cheaply collected. If one wants to know the percent of children under six years old who are living in poverty in a neighborhood, it would be helpful if there were an environmental characteristic with a known and stable relationship to this population characteristic. The environmental characteristic could be tracked over time with relative ease and minimal cost. This could indicate the effectiveness of a policy or the needs in the neighborhood.

To find stable, generalizable relationships between environmental phenomena and population characteristics, two surveys will need to be conducted across a wide variety of built environments and cultural landscapes. The first survey is of individuals or households. This is essentially what will be replaced by neighborhood observation. However, in order to establish the relationships, there must be a reasonably accurate estimate of the characteristics themselves. The second survey is of observable characteristics of the environment. Since this is initially an exploratory analysis, a wide variety of environmental characteristics will need to be observed and recorded. In order to be useful, these characteristics need to be things that are subject to individual manipulation. The number of streetlights is not a good indicator because it is determined by government action and is changed infrequently. The number of children's toys in the front yard is a good indicator because it is a characteristic that can be changed by individuals and can be altered frequently as the population characteristics change.

I conducted a pilot survey to test the feasibility of this project. I counted the number of political yard signs visible the weekend before an election in November and an election in April in several census block groups in Riley County, Kansas. I then paired this data with the data from the 5-year 2006-2010 American Community Survey. The average number of election yard signs per 1,000 households per contested office was surprisingly stable between the two elections (21 in November 2012 and 28 in April 2013) despite one of the elections including state and national candidates while the other election was for only local candidates. In addition, I found a fairly stable relationship between the number of yard signs (normalized by the number of households and the number of contested elections) and average household size. Although the coefficients were not significant in both models, they were very similar indicating that a significant relationship may be found if the sample size was increased and the demographic estimates were more precise. Beyond demonstrating that it is possible to find stable relationships, this pilot study brought to light several issues that will be addressed in a fuller implementation: the building density of the area, the number of dwelling units, and the observational vantage. The time frame was important to the pilot study as people display political yard signs right before an election and take them down right after, however, this may or may not be relevant to other environmental phenomena.

I. The History of Neighborhood Indicators

In 1982, a popular article in The Atlantic Monthly proposed in 1982 that small signs of environmental degradation could cause people to fear their environment more and lead to additional environmental degradation and possibly other crimes (Wilson and Kelling 1982). The article, based on one study which was never submitted to peer review, spawned the "broken window" theory. The theory is that if there is one sign of disorder, then other disorderly acts will follow. In other words, if there is a window broken in a building, soon all the window will be broken. This theory was popularly adopted as a rationale for increasing community policing in many US cities in the late 20th Century (Duneier and Molotch 1999). There have been several tests of the hypothesis since then (e.g., Keizer, Lindenberg, and Steg 2008, Braga and Bond 2008) but there is not conclusive proof of the theory. The primary criticisms are that the term "disorder" is too broad. For example, graffiti is often used as a sign of disorder but visual distinction between graffiti and exterior murals can be imprecise. Certain activities such as sitting on stoops may be a desirable neighborhood characteristic to some people and a sign of loitering and criminal intent to others. The second criticism that is often leveled against tests of the theory is that correlation between an environmental characteristic and individuals' behaviors does not necessarily mean it causes the behaviors. There are many reasons to believe that a second window gets broken because of the same individual behavior that caused the first window to be broken.

The primary purpose of proposing the theory is to identify an indirect way to reduce crime. However, there are other reasons to link the environment with characteristics of the population. Neighborhood indicators is a concept that there are quantifiable manifestations of qualitative aspects of the population and environment (Kingsley 1998). Many of the indicators are characteristics of the population recorded in administrative records or in surveys such as the American Community Survey. But some of the indicators are related to the environment. Kingsley (1998) lists environmental attributes such as building code violations, vacant parcels, and demolitions among possible indicators. Gurnsey and Pratt (2007) add characteristics found in administrative records such as water or electric shut-offs, water usage and property sales and foreclosures. Galster, Hayes and Johnson (2005) found home mortgage approval rate, the number of home mortgage applications and the sale price of homes to be related to most other demographic characteristics they analyzed. Clearly, there is some link between the built environment and the people who live in that environment. What is missing is some way to reliably quantify the environmental and demographic characteristics and define their relationship.

The neighborhood indicator data is important to the missions of a vast array of organizations. Guernsey and Pettit (2007) chronicle the status of data collection by local partners in the National Neighborhood Indicators Partnership. They list 55 different types of data being collected in by the member organizations covering health, education, housing and public assistance. Furr-Holden et al. (2010) tied the NIfTy survey instrument with the level of exposure to violence for youth in the community. Cowan and Kingsley (2007) relate anecdotally how some of the data has been used. Organizations in several Cleveland neighborhoods used data on properties such as the owner's name and ownership history and the condition of the property to address nuisance properties. In some cases, the property could be acquired by an organization, in other cases, the owner can be contacted or fined, or to take legal steps to address the problem when the owner cannot be located. Nashville used a combination of the assessor's parcel data, which records the age of the building and voter registration data, which records the birth date of the registrar, to identify seniors who would be eligible for CDBG funds to replace lead pipes. And yet, there is still information that organizations would find useful in their missions. Kingsley (1998) lists all the desired data that a Cleveland community building initiative would find useful to carry out their function or measure their performance. Among the 122 desired indicators, only 42 percent were recorded in administrative records and Census Bureau surveys. The other 58 percent they propose be collected through surveys or focus groups.

The proliferation of data in recent years has not necessarily yielded the information that organizations need. "Unfortunately most government statistics are by-products of the needs of accounting and administrative routine, and thus tell us more about the operations of government than the condition of society. (Cohen 1969, 14)" Certainly, Cleveland can survey residents and businesses to discover the data that they are looking for however this is costly and time consuming. It would be much nicer if there were true indicators with established and stable relationships between the characteristic that is needed and some easily observable characteristic. Some of the characteristics on the list are qualitative and cannot be related quantitatively to observable phenomena. Many others are quantifiable things like the number of active block clubs or watches, involvement in city boards, commissions and other activities, participation in neighborhood events, parental involvement with children's homework, and participation in church and service activities (Kingsley 1998, 8-10). While the qualitative data that many neighborhood indicators try to suggest is useful, there is considerable room for improving the variety, geographic scale and frequency of quantitative data. This quantitative data on demographic characteristics can be valuable to writing policy, implementing and evaluating it.

II. Linking Quantifiable Environmental Characteristics with Quantifiable Population Characteristics

I propose implementing a series of surveys to test the stability and generalizability of relationships between the built environment and the population. To establish a stable relationship, two surveys will need to be conducted across a wide variety of built environments and cultural communities. To link the characteristics, accurate surveys of both must be conducted. The American Community Survey has opened possibilities with its frequent releases at small geographic scales, however it is not accurate enough for this purpose. The average across 5 years is too long for characteristics that may vary such as income and unemployment. In addition, the sample size is too small for the kind of precision that is needed to find these relationships. The surveys must be conducted across a wide variety of built environments. Evidence of, for example, the number of children may be different in places that are primarily apartment buildings and places that are primarily single-family dwellings. The surveys must be conducted across many different cultural environments. By this I mean in different parts of the country and in neighborhoods that have differing race and ethnic compositions. Norms in a predominantly black neighborhood in Biloxi, Mississippi may be different than a predominantly black neighborhood in Seattle. Within the same city, a Hmong neighborhood may have different norms for residences than a German neighborhood. These differences must be included and accounted for in the analysis.

a. Survey of population characteristics

The survey of the population characteristics will be based in part on the characteristics collected by the Census Bureau in the American Community Survey. In addition to some of those characteristics, the survey instrument will also address characteristics that are important to local organizations. Some of these can be gleaned from the literature but the majority of the questions will be shaped by input from active organizations in the places surveyed.

The unit of analysis is the neighborhood. It will be helpful if some of these neighborhoods conform to block groups defined by the US Census Bureau so that data comparisons can be made. However, it is important that the areas be large enough to have meaningful averages and small enough for those averages to be different from the community at large. These areas should also have some meaning to the community whether that be because it is a neighborhood or a service area. The sample frame is all of these units that meet the density requirement. The sample is a random selection of these areas. The survey is sent, much like the American Community Survey, to a sample of housing units in those areas.

The survey procedures will be similar to those of the American Community Survey (US Census Bureau 2009). The first contact will be a postcard announcing the survey. This will be followed by the actual survey. A week later a reminder postcard will be sent. Five weeks after the original survey was sent, a follow-up survey will be sent. If there is no response after eight weeks, personal visits will be arranged.

b. Survey of environmental characteristics

The survey of environmental characteristics will include a wide variety of characteristics from commonly collected variables like vacant lots to more unusual characteristics like the number of stairs. Some characteristics will be temporally sensitive. Counting the number of visible children's toys outside is probably best done during in the afternoon as the toys may be put away during the evening when children are not likely to be playing with them. In Minnesota it would be misleading to count the toys during the winter because there is usually a lot of snow on the ground. However, in Louisiana, winter might be an excellent time to count the toys as the weather is usually quite pleasant. Other characteristics will not be sensitive to these temporal and geographic differences. The complete list of characteristics will be drawn from the literature as well as from extensions of popular theories such as the broken windows theory.

The sample of geographic areas will be the same as the sample for the population survey. However, the survey of environmental characteristics will include all parcels and public areas rather than a sample as the population survey uses. This is because while the demographic characteristics are tied to people who live in houses or apartments, the environmental characteristics are not necessarily tied to any specific parcel. They could easily be in the public space or straddle parcels. The procedures will be to survey the area recording the characteristics parcel by parcel. These can be randomly checked later for accuracy. The surveys will all happen on foot and during hours when the characteristics are most visible.

III. Pilot study: Counting campaign yard signs

To test the feasibility of the proposal, I conducted a pilot environmental survey. In the pilot, I focused on one characteristic: campaign yard signs. I conducted the survey twice: once before the November 2012 election and once before the April 2013 election, both times in Riley County, Kansas. I surveyed a two different samples of Census Block Groups with the help of several assistants. I compared the results with the demographic characteristics in the 2006-2010 American Community Survey. I found a fairly stable relationship between the number of political yard signs per contested office per 1,000 households and the average household size. Approximately 100 signs per 1,000 households for every contested office is related to an increase in the average household size of one person. While this relationship was not significant for both samples, it did remain fairly stable. The lack of significance may be due to the small sample size, especially of the April 2013 sample. In addition, the American Community Survey is essentially an average across five years and can have a high error rate for small areas. While this evidence is promising it is far from convincing. A more comprehensive test of the theory is needed.

In the past year there have been two elections in Riley County, Kansas. The first was November 2, 2012. This election included the president for the United States as well as state and county offices. There were four contested offices[2] in Riley County in this election cycle: President of the United States, Kansas State Senate district 22, Kansas House seat for district 66 or 67 (depending on location), and Riley County Commissioner for district 2 or 3 (depending on location). Although there are three county commission districts, all of the areas in the sample were covered, at least in part, by district 2 or 3. The second election was April 1, 2013. This election cycle included only local offices. Two of the following offices were contested in each of the areas sampled: Manhattan City Commission, Manhattan School District 383, Ogden City Council, and Ogden Mayor. Although elections that include presidential candidates historically have higher voter turnout, there is little evidence that there is a link between the offices included in an election and the number of yard signs displayed. In fact, in November 2012, the vast majority of the signs were for the state and local candidates. The average number of signs per 1,000 households per contested office for the samples from each election was fairly similar: 21 in November 2012 and 28 in April 2013.

The sample frame for this study was all the block groups in Riley County. The number of households in these block groups ranges from 0 to 1,291 households[3] and ranged in size between 0.06 and 218.86 square miles.[4] I drew a sample of 10 block groups for the November 2012 survey (table 2). These ranged from 259 households to 1,265 households and ranged in size from 0.07 square miles to 218.86 square miles. Because I had limited time to survey (one weekend), I threw out the largest block group (at 218.86 square miles). This left nine block groups in my sample with the same range in the number of households but now with a maximum geographic size of 21.52 square miles. For the April 2013 survey I again drew a sample of 10 block groups (table 2).

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2. A contested office is one in which there are more people running than open seats. Two people running for a senate seat would be a contested election. Five people running for four city commission seats would also be a contested election. It does not include ballot measures or referendums.

3. 2010 US Census, Table H1. Retrieved using American FactFinder.

4. Calculated by the author using US Census Bureau 2010 Tiger Line files for Riley County Block Groups and Kansas North State Plane projection.

Table 2. Block groups in the November 2012 and April 2013 samples.

Dropped	Block group	area (square miles)*	Households**
	November 2012 sample		
	3031	0.07	259
	8015	0.10	424
	7004	0.13	301
	8012	0.16	404
	7003	0.27	398
	2001	0.37	875
	2002	0.73	1265
	2003	1.98	707
	3023	21.52	302
X	3024	218.86	617
	April 2013 sample		
	5002	0.06	512
	3042	0.23	594
	5004	0.66	495
	6004	1.03	1088
X	0021	2.22	988
	9001	4.67	1024
	6001	5.15	376
X	0022	18.48	341
X	3021	55.87	844
X	0001	106.46	0

* Calculated by the author using US Census Bureau 2010 Tiger Line files for Riley County Block Groups and Kansas North State Plane projection.

** 2010 US Census, Table H1 Retreived using American FactFinder.

These ranged from 0 to 1,088 households and from 0.06 to 106.46 square miles. I had fewer people assisting me with the second survey so I threw out the largest block group at 106.46 square miles (this block group had 0 households). I attempted to survey the next largest block group at 55.87 square miles but I ran out of time before the survey was half complete so I threw out this block group as well. Finally, I surveyed two block groups that make up Fort Riley, an army base in the county and found no yard signs. I discovered after the fact that political signs are banned on the base so I eliminated these block groups from the sample as well. The final sample for the April 2013 survey was six block groups ranging from 376 to 1,088 households and from 0.06 to 5.15 square miles.

Both elections were on Tuesdays and the surveys took place between Friday afternoon and the Sunday before the election. All block groups in both samples except one block group in the first sample were surveyed from inside cars. The surveys were done in pairs with one person driving and the passenger recording the signs and acting as navigator. The surveys were conducted during daylight hours. The yard signs were recorded by candidate and by size using hash marks. The specific locations (for example, the parcel) were not recorded.

Totals for each of the block groups were then paired with demographic information from the 2010 Census and the 2006-2010 American Community Survey. I ran several correlation tables using the November 2012 data to identify likely relationships using the absolute number of yard signs and the number of yard signs per 1000 households (table 3).

Table 3. Correlations between the number of yard signs (or the number normalized by the number of households) and demographic characteristics from the 2010 Census or the 2006-2010 American Community Survey. Only characteristics with correlations significant at the 0.05 level are included.

	November 2012		April 2013	
Demogrpahic characteristic	number of yard signs	number of yard signs per 1000 households	number of yard signs	number of yard signs per 1000 households
Total number of people living in owner occupied housing units with a mortgage			0.93	0.80
Total number ofpeople living in owner occupied housing units owned free and clear	0.68		0.91	0.90
Average household size	0.78	0.72		
Average household size for owner occupied housing units	0.78	0.71		
Average household size for renter occupied housing units	0.69			
Total number of owner occupied housing units			0.94	0.83
Total number of owner occupied households headed by a person age 25 to 34			0.85	
Total number of owner occupied households headed by a person age 35 to 44			0.93	0.80
Total number of owner occupied households headed by a person age 45 to 54	0.72		0.96	0.82
Total number of owner occupied households headed by a person age 55 to 59	0.73		0.77	
Total number of owner occupied households headed by a person age 60 to 64			0.84	0.72
Total number of owner occupied households headed by a person age 65 to 74	0.90		0.84	0.78
Total number of owner occupied households headed by a person age 75 to 84	0.78		0.78	0.81
Total number of owner occupied households headed by a person over 85	0.69			
Total number of renter occupied housing units		-0.70		
Total number of renter occupied households headed by a person age 45 to 54			0.73	
Total number of renter occupied households headed by a person age 55 to 59			0.89	0.72
Total number of renter occupied households headed by a person age 60 to 64			0.92	0.74
Total number of renter occupied households headed by a person age 65 to 74			0.88	
Number of males age 15 to 17	0.69			
Number of males age 45 to 49			0.90	0.73
Number of males age 50 to 54	0.67		0.94	0.79
Number of males age 55 to 59	0.71		0.83	0.72
Number of males age 60 to 61			0.76	
Number of males age 62 to 64			0.92	0.84
Number of males age 65 to 66	0.70		0.86	0.75
Number of males age 67 to 69	0.83		0.86	0.72
Number of males age 70 to 74	0.78		0.84	0.85
Number of males age 75 to 79	0.92		0.79	0.78
Number of males age 80 to 85			0.72	
Number of females age 15 to 17	0.77			
Number of females age 45 to 49	0.72		0.89	
Number of females age 50 to 54			0.90	0.75
Number of females age 55 to 59	0.81		0.78	
Number of females age 60 to 61			0.86	
Number of females age 62 to 64	0.68		0.76	
Number of females age 65 to 66			0.86	0.75
Number of females age 67 to 69	0.84		0.76	0.73
Number of females age 70 to 74			0.85	0.81
Number of females age 75 to 79	0.83			
Number of females age 80 to 85	0.73			

Table 3. continued

Median age				0.78	
Median age of males				0.79	
Median age of females				0.76	
Percent of people who are white		0.68			0.79
Number of nonfamily households	-0.88				
Number of 1 person households				0.91	0.88
Number of 2-person households				0.84	0.75
Number of 6-person households	0.72				
Number of househods with 7 or more people	0.72				
Average family size	0.82				
Median household income	0.81				
Aggregate household income				0.71	
Number of people who drive to work alone				0.80	

This helped me to identify some hypotheses which I could then verify with the April 2013 sample. The first hypothesis is that the number of yard signs is related to average household size. The second is that it is related to the number of renter occupied housing units. A third hypothesis in the same vein is that the number of yard signs is related to the proportion of housing units that are renter occupied. Finally, I hypothesized that the number of yard signs is related to the percent of the population identifying as white. The results of the four models are in table 4.

Table 4. Regression results for the four hypotheses derived from the November 2012 sample.

Sample	intercept	coefficient	R^2
	average household size		
Nov 2012	2.11 ***	0.012 *	0.448
Apr 2013	2.04 **	0.008	0.214
	total renter occupied units		
Nov 2012	413.75 ***	-6.698 *	0.413
Apr 2013	443.10 *	-1.750	-0.209
	percent renter occupied units		
Nov 2012	0.74 ***	-0.010	0.302
Apr 2013	1.02 **	-0.015 *	0.812
	percent white		
Nov 2012	83.01 ***	0.292 *	0.380
Apr 2013	84.83 ***	0.084	-0.213

*** significant at the 0.001level; ** significant at the 0.01level; * significant at the 0.05 level

R^2 is the adjusted R^2.

Despite the small sample size in the two samples, the intercepts and coefficients were very similar in the November 2012 sample and the April 2013 sample for the model where average household size was the dependent variable. The coefficient in the second model was not significant but it was of similar magnitude and the models had reasonable adjusted R2 values (0.448 in November 2012 and 0.214 in April 2013). In a district with one contested office, every 100 signs per 1000 households is related to an increase of one person in the average household size according to the November 2012 model and every 125 signs per 1000 households is related to an increase of one person in April 2013 model. The similarity of the two models suggests that there may be a stable relationship between this environmental characteristic and this demographic characteristic, at least in Riley County.

The model where the number of renter occupied units was the dependent variable has a similar intercept in both models but the coefficients are different and the coefficient is not significant in the April 2013 model. In addition, the adjusted R2 for the second model (-0.209) is too low to demonstrate a relationship. The proportion of renter occupied units is more promising. While not significant in the first model, the coefficients are similar in the two models and the adjusted R2 values are reasonable. However, the intercepts are quite different in the two models. If this is a significant relationship, more research must be done to establish this. The final model, where percent of the population identifying as white is the dependent variable, the intercepts are similar but the coefficients are quite different and the adjusted R2 values are very low.

The relationship between average household size and the number of campaign yard signs in a neighborhood seems to be related however, more research is needed to establish the true relationship, the other factors that may be involved in the relationship (such as built environment) and the stability of the relationship. This pilot study has demonstrated that these relationships may be found and quantified but that there are additional things to consider. Some of the factors that hindered this study and will be rectified in the future are:

1. The temporal disparity between the environmental surveys (done in 2012 and 2013) and the demographic surveys (the 2010 Census and the 2006-2010 American Community Survey). The difference between the two prevents the estimation of precise relationships.

2. There is relatively little diversity in the built environment in Riley County. Most block groups are primarily single family residences. Some have more apartment complexes, others have larger lots or farm land but they are fairly similar within the range of possible built environments. This means that the results cannot be tested for robustness across many different environments.

3. The cultural landscape is also very homogenous in Riley County. Because it is a college town with a large army base close by, the population tends to be younger and more temporary than in other towns of similar size. It is possible that the relationship described here reflects that however, it is not possible to know this without testing it in other cultural settings.

4. The geographic size of the survey area was a major factor in my ability to survey it, even with the help of assistants. Two block groups were dropped because of the size and a third had to be dropped when the survey took too long to complete. In the future, the sample frame must be limited to areas that are much smaller, probably under 1 square mile. This means that the units of analysis cannot always be census-defined block groups.

5. The sample frame did not consider the density of the environment. However, human alterations of the environment are generally made where humans spend the most time. Farmland and natural areas are less likely to have the types of environmental characteristics that will be related to demographic characteristics. Some threshold for the density of residences or built environment must be established.

6. Defining what counted as a campaign yard sign was fairly easy, however other environmental characteristics may not be so easy to define or count. How do you distinguish a child's toy? Is a play gym with swings and a slide one toy or two? Is a doll equal to a swing set? These definitions need to be clear and intuitive. They also need to be stable over time.

IV. Next steps

There are two next phases. In the short term a more comprehensive test of the theory is needed to establish the credibility of the method. In the long term, assuming the method is credible, the surveys must be conducted across a wide array of places. I am planning a more comprehensive test for the fall 2013 in Riley, Pottawattamie and Geary counties in Kansas. This test of the method will include both demographic and environmental surveys of a wide variety of characteristics based on the needs of organizations in the three counties. The sample frame will be narrowed to include only areas that meet the density requirement. In addition, it will deviate from the block group format so that all the areas are under one square mile and the surveys can be completed on foot. In addition, the sample will be much larger to reduce the error in the model. While the results of the larger test will only reflect the relationships within the three counties, it can establish the potential usefulness of the method.

The full implementation of this method requires partners across the US. In order for this method to be broadly useful, it must be robust across time and space. Therefore, both surveys must be implemented in a variety of places. In order to do this, multiple partners need to be involved in this project. In addition to overseeing the surveys in many different locations, the additional researchers will bring different insights and criticisms to the establishment of the relationships between the two realms.

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Assessing Economic Impacts of Agricultural Cooperatives

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Abstract. Agricultural cooperatives are different than other types of business because they exist to provide value to their members through collective marketing and/or collective purchasing opportunities. Cash patronage and equity payments and single-level taxation are other unique aspects of cooperative businesses. This paper describes the development of an economic impact model incorporating these business characteristics. The largest component of most agricultural cooperatives' revenue is a pass-through of agricultural commodities. Many supply sales are a backward link in the commodity production, so the commodity sectors in IMPLAN (MIG 2004, 2012) are modified to avoid double counting of inputs purchased under the cooperatives' collective marketing purpose while still accounting for sales of household purchases, such as garden supplies at retail value. Cooperative status is simulated by modifying the income sources in the cooperative model to limit payments to investors and multi-level taxation (Folsom 2003). A portion of other property income, which is subject to corporate-level taxation and revenue leakages, is specified as proprietors' income in IMPLAN's agricultural commodity sectors. The non-cooperative model follows the default IMPLAN distribution of proprietors' income and other property income. The difference between the two models estimates the value of the cooperative status. Due to sustained demand by individual cooperatives, an economic impact program has been standardized and implemented across Texas.

Introduction

Agriculture is an important component of the Texas economy. While production agriculture makes up less than percent of the state's contribution to GDP, production underpins the state's larger 8.9 percent contribution (McCorkle, et al. 2012). Most commodity producers are members of at least one agricultural cooperative.

Cooperatives are formed to pool the marketing and/or purchasing power of individual farmers. However, as farms have gotten bigger and technology has allowed farmers to source inputs globally, cooperatives have faced increased competition from other firms. At the same time, cooperatives' structure and value are often misunderstood. Cooperatives are member-owned businesses that return profits to members through patronage payments and dividends. Members also have a say in the governance of the organization. Cooperatives receive tax benefits such as single level taxation as opposed to paying corporate tax.

Cooperative leaders have recognized that if they fail to explain their benefits to the public, they may lose both market power and political sway (Park, Baros, and Dudensing 2009), particularly as agriculture's share of the economy decreases (McCorkle, et al. 2012) and the membership of the state and federal legislatures shifts to urban areas. In 2007, the Texas Agricultural Cooperative Council (TACC) approached the Roy B. Davis Cooperative Program of the Texas A&M AgriLife Extension Service to conduct an economic impact analysis of the agricultural cooperatives in Texas. Initially, locally-owned cooperatives were surveyed to determine economic impact across the state. The study found that 96 participating cooperatives generated 2,000 jobs and $232.4 million in GDP contribution to the Texas economy in 2007 (Park, Baros, and Dudensing 2009). Regional cooperatives were included in a subsequent survey. In 2011, individual cooperatives began requesting economic impact analysis to communicate their value locally at membership meetings and to obtain grant funding from local community and economic development corporations.

This paper describes the methods used to analyze the economic impact of cooperatives relative to corporations and other non-cooperative firms in the same industry and the creation of a standardized method to provide impact estimates to cooperatives through the state Extension service. The paper is organized as follows: Section 2 includes a review of the literature surrounding economic impacts of cooperatives, Section 3 discusses the methods for assessing economic impact of cooperatives, Section 4 describes the process for conducting standardized impact analyses of local cooperatives through Extension and provides an example of a cooperative impact analysis, and Section 5 concludes.

Literature Review

Most previous studies of cooperatives were conducted in the upper Midwest. Coon and Leistritz (2001) surveyed North Dakota cooperatives. They averaged expenditures by category and cooperative type (agricultural processing, credit, etc.) for the 70 respondents and extrapolated the averages across the all the state's cooperatives by type. They modeled cooperatives' extrapolated expenditures using the North Dakota Input-Output model. They found that agricultural processing cooperatives had the largest expenditures, primarily because of the large quantity of raw commodity purchased within the state. The economic impact of all cooperatives was $6.1 billion, including $2.2 in personal income.

Zeuli et al. (2003) surveyed 798 cooperatives in Wisconsin and used employment, income, and cash patronage refund data in a social accounting matrix (SAM) model to estimate impacts of the state's cooperatives. They found that agricultural marketing cooperatives, the largest group of cooperatives, supported $263.1 million in income and almost 8,300 jobs across the economy. Farm supply and service cooperatives supported $254.1 million in income and almost 8,200 jobs in Wisconsin. Cash patronage refunds and dividends paid by all types of cooperatives (not just agriculture and farm supply) contributed 4,600 jobs, more than $114 in income, and more than $500 million in GDP (gross domestic product or value-added).

The SAM model was not adjusted to reflect cooperative status. In fact, the researchers noted that the study did not differentiate cooperatives from other organizational structures and thus did not account for unique relationships between the cooperative and the regional economy, including the potential for cooperatives to purchase a higher share of inputs locally.

Zeuli et al. noted that economic impact analysis is only one measure of an enterprise and fails to capture other aspects of cooperative benefit, including the formation of leadership (human capital). The study also did not measure the savings that cooperatives afford their members or how those savings might be spent in the local economy. The study did report the value of taxes paid by cooperatives.

Folsom (2003) noted that research including the two previously reviewed studies assume that if the cooperative did not exist, no economic activity would ensue. Thus, Folsom accounted not only for the value of economic activity but also the portion of that activity directly attributable to cooperative status. He attributed cooperatives' economic contribution to single-level (non-corporate) taxation and the ability to retain economic benefits locally in the form of profits (patronage) and dividends paid within the region as opposed to corporate dividends paid to shareholders outside the region. He accounted for single-level taxation and local ownership in the IMPLAN model by treating all other property income as proprietors income. Other property income in the IMPLAN model includes rents and dividends, which have leakages outside the study region, whereas proprietors income is generally paid within the local economy. A second model used default IMPLAN other property income and proprietors income and served as a baseline to measure the value of cooperative status.

Folsom estimated a contribution of $10.9 billion in gross sales and more than 79,000 jobs from 311 responding Minnesota cooperatives and 185 credit unions. Local ownership and single-level taxation accounted for $600 million. The 189 responding agricultural cooperatives contributed $8.4 billion in sales. Folsom estimated that all of the state's agricultural cooperatives contributed $17.3 billion in gross sales with $647 million attributable to their cooperative status.

Folsom also noted that IMPLAN has been used to measure the impact of single cooperatives. However, none of the preceding studies discussed the possibility of double counting sales if a commodity is marketed and inputs are supplied. For example, Coon and Leistritz (2001) identified 100 farm supply cooperatives and 110 grain handling cooperatives among North Dakota's 405 cooperatives in 2004. The implicit assumption relevant to impact analysis is that that grain handling cooperatives do not sell inputs to grain production. While this may be appropriate in North Dakota, the assumption does not hold in Texas where 28 of 34 locally-owned cooperatives with grain sales in 2007 also had supply sales (Park, Baros, and Dudensing 2009).

Methods

For the initial study of local cooperatives, researchers designed a questionnaire that was promoted by the Texas Agricultural Cooperative Council (TACC) to its members. The questionnaire (Appendix A) had two themes: questions related to economic contribution and 2) questions about its membership. Cooperative managers were asked to provide information about their sales by category.

Questionnaires were sent to 105 locally-owned cooperatives, but nine were not currently operating and declined to participate in the study. The other 96 cooperatives responded, providing a nearly 100 percent response rate, which was possible through the efforts of TACC leadership. Categorized expenditures for each cooperative were summed because all locally-owned cooperatives were represented and there was no need to extrapolate results to a larger population.

The direct sales were characterized into retail operations and total sales value. Retail operations included the sale of fuel, fertilizer, farm supply, garden supply, tire services, etc. Overall sales included the value of the commodities that passed through the cooperatives. For example, cooperatives reported the value of wheat sold or cotton ginned, but the cooperatives themselves generated only storage, handing, and ginning fees and in some cases a sales margin; most of the value of the commodity sale was due to production by cooperative members. Furthermore, adding the value of commodities and the value of inputs would result in double counting of sales in an input-output model.

Sales by expenditures category were modeled using IMPLAN (MIG 2004), which models backward linkages in the economy. For example, the sale of cotton results in sales of seed, fertilizer, pesticide, diesel fuel, labor, etc. Input suppliers such as seed dealers then purchase inputs from other businesses (indirect effects), and laborers spend their income to purchase supplies such as food and clothing (induced effects). While cooperative's seed, fuel, and fertilizer sales represented revenue distinct from that of commodity sales, including both final commodity sales and input sales in the IMPLAN model would result in double-counting of sales within the regional economy. To prevent double-counting, the value of seed, fuel, and fertilizer needed based on IMPLAN use coefficients was estimated and subtracted from the reported sales value of each of inputs. The value of commodity sales and the remaining value of the retail sales (including the full value of other sales categories) were estimated

Following Folsom (2003), cooperative status was modeled by converting other property income to proprietors income in the IMPLAN model. Because income is retained among agricultural producers participating in the cooperative, only the income distributions of agricultural commodity sectors were adjusted. For most crops, including cotton, the default IMPLAN value for other property income was replaced with a "0" value and added to the default proprietors income. Researchers determined that for Texas grain production, it was more appropriate to treat only half of other property income as proprietors income to recognize the significant value of income that accrued to absentee landlords. Models run with default IMPLAN values for other property income and proprietors income served as the baseline to determine the value of cooperative status based on local profits and single-level taxation. Four IMPLAN scenarios were created: a cooperative model and a default model for the retail operations case and the total sales case. One reason for not modeling patronage and dividends themselves is that not all organizations made payments; some cooperatives retained the funds to support expansion or other operations. While value was generated by the cooperative, it would not be captured by payments.

Texas locally-owned agricultural cooperatives were found to have $362 million in retail operations contributing $232 million to GDP and 2,000 jobs across the state's economy. When the value of commodities sold was included in the analysis (less the cost of production inputs), the cooperatives contributed $826 million and almost 20,900 full-and part-time jobs, and value of the 96 respondents' cooperative status was $86 million in GDP and almost 1,200 Texas jobs. The results of this study are detailed in Park, Baros, and Dudensing (2009). Result summary tables are provided in Appendix B. A second study was completed using the same methodology but including regional cooperatives.

Standardized Impact Analysis for Local Cooperatives

Following participation in the state-level impact studies, cooperatives began to request analyses of their individual impacts. Initially, Extension economists conducted full analyses similar to the state-level studies using current IMPLAN data (MIG 2012), providing multi-page reports with multiple study areas (e.g., immediate county and larger service territory) as a free service. However, by late 2012 several factors required the program to be formalized and simplified:

- The volume of reports requested had tripled.
- Extension personnel had to communicate with cooperative managers by e-mail and/or telephone several times to get the information needed for the analysis.
- Cooperative managers often provided one or more years' audits, and Extension specialists sifted through the audits (which are different for each organization) to determine categorized sales.
- Managers frequently requested reports with a short turn-around for annual meetings.
- Annual meetings tended to be clustered within short time spans in the spring and fall.
- A several page report and several hours of work were being boiled down to a bullet or two on a placemat at the meetings.

Extension specialists created a data entry form for managers to provide categorized sales, service territory, number of employees, and year of data (Appendix C). Specialists also built an Excel template to simplify data entry, including adjustments to other property income and proprietors income and compensation for input use to avoid double counting (Appendix D). The methodology for analyzing the impact of the individual cooperative remains the same as described in Section 3 except that cooperatives often employ fewer people on a full and part-time basis than the IMPLAN model suggests so employment and wages are modified in the retail operations sectors. Results are reported on a standardized one-page MS Word template (Appendix E).

While cooperative managers were interested in the value of cooperative status, they were reporting the larger value of their retail operations and/or total sales on their placemats. Thus, the spreadsheet template is set up to calculate the difference between cooperative status and IMPLAN default models. However, that difference is not provided in the report, and the default models need not be run.

Only one region, usually the service territory, is modeled. In addition to saving time on the analysis, limiting the analysis to one region avoids impacts in the sub-region being greater than impacts in the full region, which can occur (and has) when a ZIP-code level region has a lower share of income leakage than does a county-level region.

Conclusion

The formalized process has simplified and shortened the analysis and reporting process for Extension personnel. The data collection process is also easier for both Extension specialists and cooperative managers, although data still often needs clarification. However, less information is provided than in the previous, lengthier reports.

As noted by Zeuli et al. (2003), the methods used in this study fail to capture the savings to members or the local benefit of improved member profitability. Neither the state-level study nor the individual analyses report the value of taxes paid by the cooperatives, although evidence in other Texas projects has indicated that these taxes are substantial; cooperatives often have one of the highest property tax levies in their home county (although this benefits primarily one county--and one school district--and not the overall service territory). Furthermore, the Texas studies do no capture the important role that many cooperatives play in fostering leadership, offering scholarships, and promoting a sense of community.

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2013 MCRSA Conference Proceedings

Mid-Continent Regional Science Association

Regional Spatial Analysis of Impaired Surface Waters

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Abstract. This paper focuses on three related aspects of implementing a watershed (i.e., regional) approach for surface water quality assessments. First, I explore the recent adoption of a watershed approach for surface water quality assessment in New Jersey. New Jersey may be the only state using a subwatershed assessment unit for reporting impaired waters. Next, I discuss pitfalls in extending land use profiles directly as an indicator of water quality, and third I argue for applying spatial analysis techniques to inform the relationship between land use metrics and surface water quality impacts. GIS-based spatial analysis tools are used to analyze the degree of spatial autocorrelation among subwatersheds and to perform spatial regression on possible explanatory variables such as land use, surface water discharges and impervious surface with the probability that a watershed is impaired.

Keywords: GIS, spatial analysis, water quality management

Introduction

Traditionally water resource management in the United States has been reactive not proactive. To promote proactive management of water resources, the United States Congress passed the Federal Water Pollution Control Act Amendments of 1972, also known as the Clean Water Act (33 U.S.C. §1251 et seq. [1972 and subsequent amendments]). The Clean Water Act (CWA) gave the U.S. Environmental Protection Agency (EPA) a clear mandate to regulate and enforce the provisions of the CWA. Section 101(a) of the CWA states,

(a) The objective of this Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.

(a)(2) it is the national goal that…water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved…

This language has been interpreted by the EPA and most states to mean that surface water resources should be fishable and swimmable.

In an effort to achieve the goals of the CWA, the EPA promulgated rules aimed at reducing discharges of pollutants into water bodies. These rules include requirements for states to manage, monitor and report water quality conditions in their respective state. Water quality management has traditionally and is still typically handled by limiting pollutant discharge through permits, known as National Pollution Discharge Elimination System (NPDES). In the 1990s, the EPA began delegating authority for monitoring and assessment of intrastate waterbodies to the respective individual states. This included information regarding whether waterbodies were meeting their designated uses, as defined by water quality standards. The primary mechanisms from the CWA to accomplish monitoring and assessment of U.S. waters are the Water Quality Inventory (WQI) Report (Section 305(b)) and the Impaired Waterbodies List (Section 303(d)) [see 33 U.S.C. §1251 et seq.]. These had been considered separate tasks and deliverables for many years, but beginning in 2002, the EPA required states to submit an Integrated Water Quality and Monitoring Report which would include both the WQI report and the Section 303(d) list of impaired waters, along with other relevant information including plans to improve the monitoring and assessment capability and data quality. According to the New Jersey Department of Environmental Protection (NJDEP), the New Jersey Integrated Report (NJDEP 2006) also contains information on: delineation of water quality assessment units; methods to assess designated use attainment; pollutants and waters requiring improvement, usually through a total maximum daily load (TMDL) analysis; and progress toward achieving comprehensive assessment of all waters.

In New Jersey, as in the rest of the United States and many other parts of the world, there has been a marked improvement in water quality over the past 40 years through the control of point sources of pollution (NRC 1999, p.20). However, it is estimated that in the United States alone, there are more than 21,000 river segments, lakes and estuaries (NRC 2001) that have been identified as violating one or more water quality standards. These violations primarily result from a lack of attention to impacts from non-point source pollution (Arnold and Gibbons 1996, NRC 1999, NRC 2001). This has led the EPA to require states to be more diligent and comprehensive when monitoring and assessing water quality by using a watershed approach. In addition, the ability to identify regional impacts on water quality can help protect the significant economic value that many states derive from recreational activity in and around their waterways (e.g., Jackson et al. 2012 and Outdoor Industry Association 2012). Innovative watershed-based approaches to water resources monitoring may provide an advantage for managing three key change agents, 1) significant contributions of non-point source pollution, 2) rapidly changing land use (from urban decay to suburban and exurban sprawl in western countries and urban growth in many developing areas of the world), and 3) global climate change, which may have profound impacts on precipitation patterns that directly influence the fate and transport of pollution into and within surface water environments.

Water Quality Monitoring and Assessment in New Jersey

Water quality in New Jersey is monitored and assessed based on water quality standards created to support various designated uses for the State's water resources. Designated uses for New Jersey waterbodies are generally meant to support recreation, water supply and aquatic life. Each of these designated uses has a corresponding set of regulatory-based water quality standards that define the condition of the waterbody necessary to support the designated use. Stream reaches of various length, lakes, ponds, estuaries, marine waters, and reservoirs are all considered waterbodies that can be used as "assessment units."

New Jersey employs three distinct methods for monitoring water quality on a state-wide basis, i.e., fixed-stations, probabilistic sampling, and targeted sampling. Each of these methods involves some degree of extrapolation of data from a collection point (point-source) to a larger portion of a waterbody or even an entire watershed. The NJDEP uses targeted sampling methods to monitor spills and for source identification, and probabilistic methodologies exclusively for lakes and estuary waters.

Extrapolation of data collected at fixed monitoring locations to varying extents of a stream or watershed is the technique used to assess the water quality of New Jersey streams and rivers. For purposes of managing water resources in New Jersey, the NJDEP has divided the state into 20 watershed management areas (see Figure 1) each comprised of many subwatersheds.

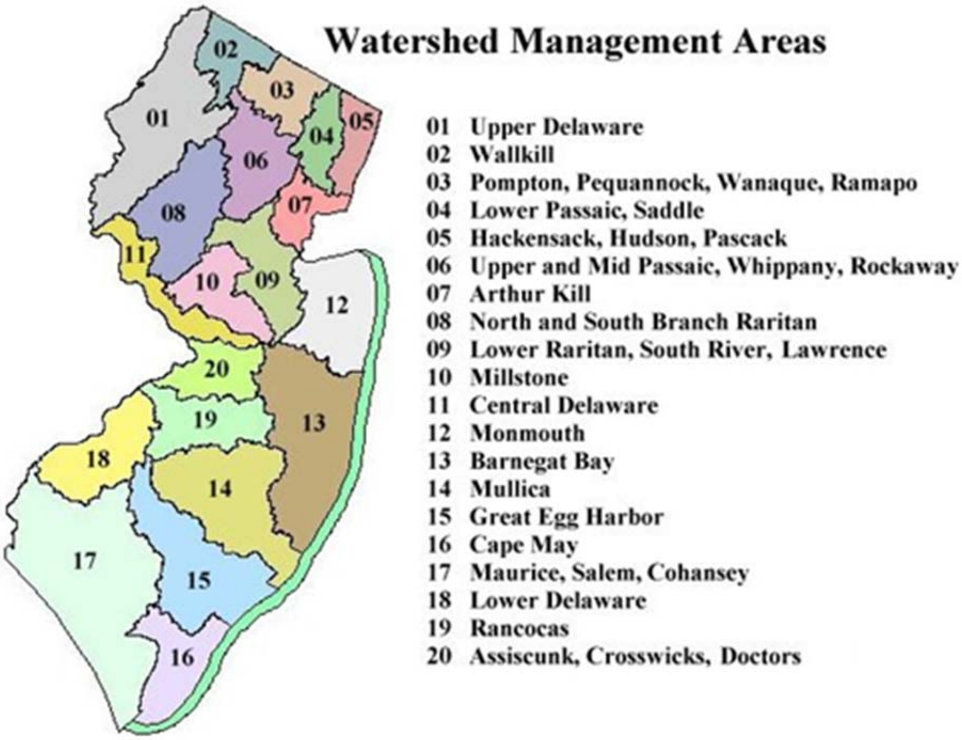


Figure 1. Watershed Management Areas of New Jersey (available from http://www.nj.gov/dep/gis/)

There are about 11,700 miles (18,800km) of mapped non-tidal rivers and streams and 6,420 miles (10,330km) of mapped tidal rivers and streams in New Jersey (NJDEP 2006). In addition, the 20 WMAs comprise 970 subwatersheds at the HUC14 level. The HUC14 level is a United States Geological Survey (USGS) designation for the fourteen digit hydrologic unit code (HUC). Hydrologic unit codes are USGS-designated geographic features that represent watersheds of various nested sizes, a watershed being an area of land whose borders are topographic highs such that all water falling on the land surface drains to a single waterbody or topographic low area. In the USGS HUC numbering system, fewer digits indicate relatively larger watersheds and more digits indicate smaller watersheds. The HUC14 subwatersheds are the smallest watershed unit used by the NJDEP in the assessment of New Jersey waters. The average size of a HUC14 in New Jersey is about 8.5 square miles (22 km2). The data and findings presented in this paper are for Watershed Management Areas (WMAs) 01, 06, and 17.

Current watershed assessment strategies: spatial extent

The CWA requires states to report the results of monitoring and assessment conducted at point locations as extrapolated results in their biennial Integrated Water Quality Monitoring and Assessment Report. The reporting units are linear miles for streams in the inventory section of the Integrated Report and discrete waterbodies for the 303(d) section of the Integrated Report. In 2006, the NJDEP changed its definition of assessment unit to maintain a somewhat artificial assessment rate. Prior to 2006, the NJDEP used stream order to extrapolate results from a monitoring station to a spatial extent measured as stream miles. This approach is essentially a localized application of the measured water quality. This served as the definition of spatial extent for assessment units until 2006. As the NJDEP changed the scale of the base resolution of stream coverages from 1:100,000 to 1:24,000, the number of unassessed stream miles increased (NJDEP 2006, Appendix E). Of course, the total number of stream miles similarly increased. However, anticipating a future increase in base resolution for the stream and river coverage to 1:2,400, and to avoid a large increase in number of unassessed stream miles (even if the ratio to total miles stayed the same) the NJDEP developed a new definition of spatial extent. The new spatial extent for stream assessment units is a watershed-based regional approach. Results indicating whether or not designated uses are attained at a point monitoring station are extrapolated to the entirety of whatever HUC14 watershed that station falls within. In this way, the attainment or non-attainment of designated uses is extrapolated to all waters within the respective HUC14. The NJDEP considers this new approach to be "more conservative" (i.e., protective) because any impairment as measured by point location analyses will result in a listed impairment for the entire subwatershed. Additionally, for each HUC14 with multiple designated use classifications, the most stringent classification will be used for the determination of impairment for the entire HUC14. It is worth noting that despite the NJDEP's view a negative result (no or very low levels of pollution) will result in the entire watershed being declared to attain the designated uses for all waters within the watershed. Even with the new watershed-based spatial extent methodology, the NJDEP has assessed all designated uses in only88 (~10%) of the 970 HUC14 subwatersheds. Full assessment of all designated uses except fish consumption has been achieved in only 241 (~25%) of the assessment (NJDEP 2006). This shows the clear need for a statistically-based approach using readily available information, which has similar spatial extent to the spatial extent used for assessment, to assess the likelihood of meeting or not meeting designated uses in New Jersey's subwatersheds.

Although there are inherent weaknesses (e.g., loss of specification and increasing overall uncertainty) in extrapolating in-stream point monitoring to an entire watershed there are several important reasons for beginning down this path. First, after decades of research on non-point source pollution and land use impacts on aquatic ecosystems, researchers have suggested a relationship between human activity, especially conversion of natural land cover to urban and agricultural uses, and resultant impacts to the hydrologic systems connected to those land areas (e.g., Schueler 1994, Arnold and Gibbons 1996, Bockstael 1996, Bolstad and Swank 1997, Naiman and Bilby 1998, and Alberti et al. 2007). Second, the EPA is pushing states to adopt watershed-based management for water resource protection and restoration. Third, although aquatic ecosystems and natural hydrologic systems are sentinels in the sense that this is where we can observe critical impacts, watersheds are where the root causes of those cumulative effects begin. In that way, watersheds are the appropriate and perhaps only geographic unit for integrative management of water resources. Healey (1998) states that "using watersheds for ecosystem management allows for a logical emphasis on the linkages between land and water."

Current watershed assessment strategies: indicators sampling

The NJDEP uses three primary types of stations in its monitoring network (NJDEP 2009, Appendix E):

1. Ambient Stream Monitoring. A network of 115 sites jointly operated by the NJDEP and the USGS. According to the 2006 Integrated Report, "the chemical/physical networks monitor conventional parameters, metals, bacteria, pesticides, volatile organic compounds (VOC's) and sediments.

2. Ambient Biological Monitoring (AMNET). This network of 820 sampling locations throughout New Jersey is primarily used for sampling benthic macroinvertebrate assemblages. Benthic macroinvertebrate species are considered important indicator species for impact to aquatic ecosystems. A subset of these locations are also used for monitoring fin fish populations.

3. Existing Water Quality (EWQ). NJDEP maintains a smaller network of sites to monitor physical and chemical conditions primarily to support antidegradation policies

In addition to the above monitoring networks, the NJDEP collects data from lake, estuary, coastal and targeted monitoring efforts. For example, Figure 2 shows the locations of primary stream monitoring sites in WMA06. Given the NJDEP's spatial extent and assessment methodology, it is important to note that some subwatersheds (HUC14s) have more than one monitoring location and others have none. Due to the anisotropy in monitoring density and because the NJDEP uses both numeric and narrative criteria to assess designated uses, the NJDEP has developed a minimum suite of parameters to determine if a designated use is attaining or non-attaining (Table 1).

Table 1. Data requirements for designated use assessment (NJDEP 2006).

Designated Use	Data Requirements
Aquatic Life	If available, benthic macroinvertebrate and fin fish data, pH, DO, temperature, total phosphorus, TDS and TSS. DO is the minimum data requirement. (Temp & DO trout)
Recreation **• Primary and Secondary Contact** **• Aesthetics (Lakes only)**	Enterococcus, fecal coliform or E. coli Aesthetic listings are “carry-overs” and were assumed to be phosphorus related. The Department is developing a methodology to better assess lakes which should be available for the next assessment cycle.
Fish Consumption	Fish Consumption Advisories for one or more parameters
Shellfish Harvesting	Fecal coliform or total coliform
Drinking Water Supply	Metals, toxics, nitrate, TDS, chloride, and source water use restrictions. The minimum data requirement is nitrate.
Industrial Water Supply	TSS and pH
Agricultural Water Supply	TDS and salinity

When there are multiple lines of evidence for a particular assessment unit (HUC14), the NJDEP has stated (NJDEP 2006, Appendix G), “the Department will use a weight of evidence approach to determine if all data within the assessment unit is of equal value.” It is clear from Figure 2 that some subwatersheds have more than one station and more than one monitoring type present in or adjacent to the HUC14. NJDEP states that where a monitoring location is in a stream that forms the boundary between two HUCs, then the data will be assumed to represent both units. The weight of evidence method will be needed in those situations.

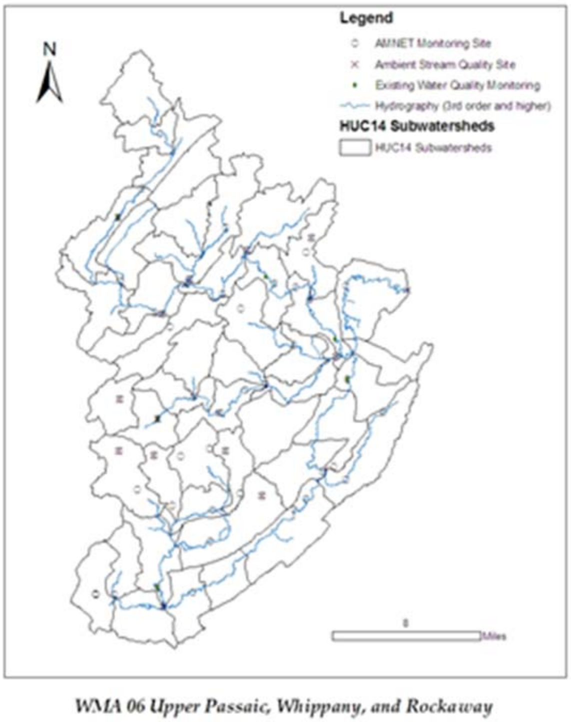


Figure 2. Stream water quality monitoring locations in Watershed Management Area (WMA) 6

Stream impairment: possible explanatory factors

One way to check the success of using subwatersheds as the spatial extent for quantifying and listing impaired waterbodies in an Integrated Report is to incorporate a metric that can be used as a proxy for cumulative effects as measured by biological, physical and chemical changes in the aquatic environments being assessed. As discussed previously, many researchers have modeled various watershed characteristics in an effort to relate them to degradation in aquatic ecosystems. Degradation of aquatic ecosystems is the primary cause of waterbodies not being able to meet their designated use goals and thereby being listed on the 303(d) list (sublists 4 and 5 of the Integrated Report). Schueler (1994) indicated positive correlations between the percent of impervious cover in a watershed or on a site and the amount of runoff, phosphorus loading and stream channel instability, and a negative correlation between percent impervious surface and macroinvertebrate populations. Bolstad and Swank (1997) showed that the cumulative impact of increasing urban and agricultural land use along a downstream gradient resulted in measurable and significant impacts on stream water quality, especially during peak discharge events. Bockstael (1996) showed a strong relationship between nitrogen loading and land use, where residential and agricultural land uses accounted for more than 83% of the nitrogen loading to the Patuxent watershed in eastern Maryland. Lathrop et al. (2007) used an impervious cover threshold of 10% (using larger HUC11 watersheds) to indicate degradation in watersheds in the New Jersey and New York Highlands. Finally, Utz et al. (2009) state that “the broad classes of urban and agriculture are surrogates for the specific mechanisms that cause the loss of sensitive taxa from streams and thus form convenient yet relevant measures for analysis.” With the weight of evidence from these studies and many others that point to a significant and measurable relationship between land use, particularly urban and agricultural, and stream health it makes sense to apply these “surrogates” to testing the NJDEP’s spatial extent extrapolation method for listing impaired subwatersheds.

The quality of water in streams and hence the ability to meet designated uses in a waterbody is directly related to the source and transport of the water prior to it entering the waterbody. In this sense, this investigation sought to define relationships for several potential explanatory variables that broadly represent those sources and transport phenomena. These can be summed up by three major categories: direct runoff from the land surface, return flows via wastewater discharge, and groundwater discharge to the waterbody. For this study, we did not include groundwater discharge because it is not considered a significant contributory pollution pathway to streams in WMAs 01, 06 and 17. These WMAs were selected for their distinctly different land use profiles. Figure 3 provides land use profiles and impairment status as ternary plots for each HUC14 in a WMA and thereby provides a collective land use profile for each WMA as a whole. Figure 4 show land use land cover for WMA06 in the more typical map view for comparison.

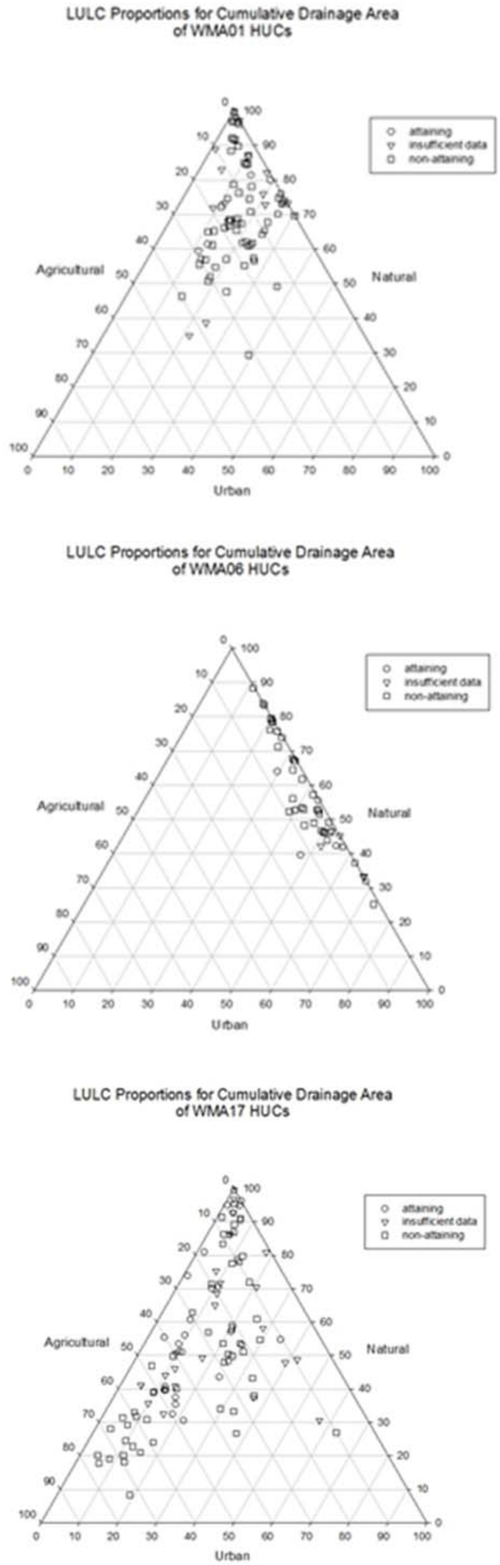
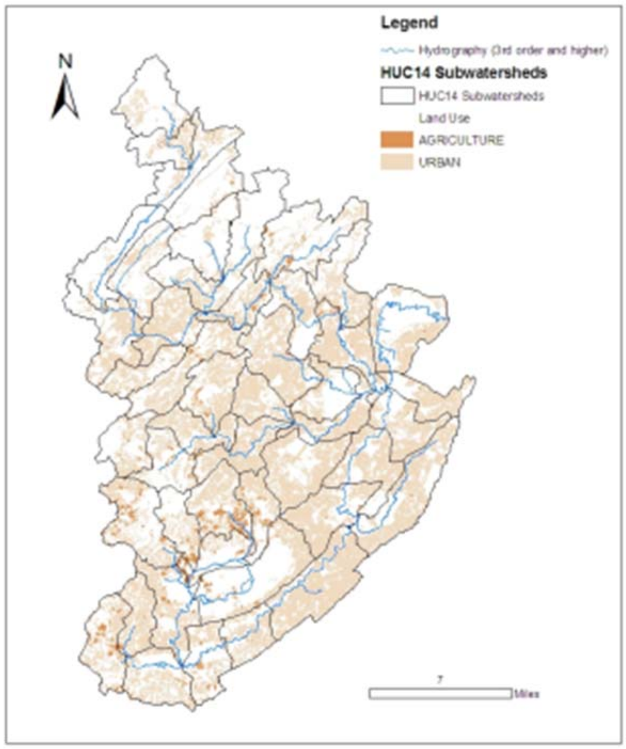


Figure 3. Land use land cover profiles for WMAs 1, 6 and 17



WMA 06 Upper Passaic, Whippany, and Rockaway

Figure 4. Agricultural and Urban Land Use Land Cover in WMA06

Additionally, this paper seeks to test the hypothesis that landscape metrics (including wastewater discharge) can be used to estimate the likelihood that a given assessment unit, a HUC14 subwatershed, is impaired. Regression analysis (both traditional static and spatially-informed) using number and location of NPDES permits and land use profiles for the target subwatersheds was the tool used to test this hypothesis. This has broad implications for water resource management. As waterbodies are listed on the 303(d) list of impaired waters, it triggers additional regulatory activity in the form of extensive targeted monitoring and possible development of a remedial action plan. The remedial action typically will take one of three forms: development of a total maximum daily load (TMDL), watershed restoration projects or water-quality based effluent limits (WQBEL). These are expensive projects to implement and have long-term planning horizons, thus making determinations of designated use and impairment status an important policy and management decision.

Regression model development

Based on a review of literature, it is appropriate to test the hypothesis that landscape metrics, especially proportions of land cover types, are good predictors of subwatershed impairment in New Jersey. Land use data for urban and agricultural land was compiled from NJDEP Geographic Information System (GIS) coverages (available from http://www.nj.gov/dep/gis/). The GIS shapefile metadata indicate that “land use” category is described using a modified Anderson (1976) classification system. The data was interpreted by NJDEP from 2002 color infrared imagery with a minimum mapping unit of 1 acre. High-resolution land use data for 2007 recently became available from the NJDEP, but not in time for this study. A non-spatial regression analysis was performed to explore relationships between the potential explanatory variables of urban land cover, agricultural land cover and impervious surface cover and number of NPDES discharges in a subwatershed and the impairment status of the subwatershed.

Because the response variable, impairment status, has a binary response, a standard linear regression cannot be used. The impairment status is 1 if the subwatershed is impaired and 0 if it is not impaired. Impairment status was considered a 1 if the HUC14 was listed on the 303(d) list (Sublists 4 or 5) of the New Jersey 2006 Integrated Report. In WMA06, six of the 46 subwatersheds are on the NJDEP Integrated Report Sublist 3 (insufficient data), but four of those six have a completed TMDL to address a previous impairment for primary contact (recreation). For the purpose of this study all six units were considered to be non-impaired.

Simple linear regression has certain assumptions such as that the response is a linear function of the explanatory variable(s) and that the error structure (how individual measurements vary from the mean or expected value) is normally distributed. It is further assumed for simple linear regression that the error structure is normally distributed with constant variance. Binary responses, with values of 0 or 1, can also be thought of as a probability, where the sum of the probabilities for the response being a 1 or a 0 must add to 1. Following Cook et al. (2000), this is expressed as:

$$\text{Prob}(Y_i=1) = \pi_i \qquad (1)$$

$$\text{Prob}(Y_i=0) = 1 - \pi_i \qquad (2)$$

So generally,

$$E(Y_i) = 0*(1 - \pi_i) + 1* \pi_i = \pi_i \qquad (3)$$

With an explanatory variable, Eq.1 becomes:

$$E(Y_i|X_i) = \beta_0 + \beta_1 X_i = \pi_i \qquad (4)$$

Equation 2 indicates that πi is a function of Xi and so the variance of Yi is also a function of πi. Therefore the assumption of constant variance is violated and inferences made on binary responses using a simple linear regression would not be valid. With binary response data, the expected response is (the probability of a 1 or a 0) is more appropriately modeled as a non-linear relationship (Cook et al. 2000, p.9). A more appropriate approach is to analyze binary response data with a logit (logistic) transformation and a maximum likelihood estimator. The logit transform transforms the non-linear relationship, between the explanatory variable and the probability that the response is one of two outcomes, to a linear one. This also keeps the predicted response bounded between 0 and 1. The logit transform is the natural log of the ratio of the probability of one outcome to the probability of the other outcome (e.g., probability of a subwatershed being impaired and the probability that it is not impaired). Based on Equation 4, the log transform looks like this:

$$\pi'_i = \ln\left(\frac{\pi_i}{1 - \pi_i}\right) = \beta_0 + \beta_1 X_i \qquad (5)$$

Use of the maximum likelihood estimator with the logit transform allows for relaxation of the assumptions that error variance be constant and normally distributed. This is important to be able to assess the fit of the predicted response to observed responses (probabilities) and be able to assess the significance of the estimated parameters (regression coefficients). This technique has been used in many applications including analysis of variables with strong spatial dependence. Some examples include: prediction of landslide hazards (Ohlmacher and Davis 2003), ecological spatial prediction of wetland plant occurrence (van Horssen et al. 2002), and spatial pattern of farmland in the Maotiao River Basin, China (Huang et al. 2007).

The first regression was run with five explanatory variables: 1) the number of permitted surface water discharges (SWD_Count), 2) the proportion of agricultural land use in the cumulative area draining to each HUC14 (Prop Cum Ag), 3) the proportion of urban land use in the cumulative area draining to each HUC14 (Prop Cum Urban), 4) the proportion of impervious surface in the cumulative area draining to each HUC14 (Prop Cum IS), and 5) the total acreage of land contributing to each HUC14. It is important, though different from many other geographical units, to use the total contribution to each HUC14 because rivers are a continuous network of converging tributaries that add to the total flow in the river (diluting effect), but also can add to the total load of contaminants (concentrating effect). Table 2 shows the results of the preliminary multiple logistic regression analysis for the full suite of explanatory variables. The whole-model test showed a significant outcome with the lack of fit test indicating a very strong fit. Surprisingly, the regression was dominated by, and only significant for, one of the five variables. The probability that any given subwatershed is listed as impaired by the NJDEP (response variable) was shown to be sensitive to only the total area (regardless of land use type) contributing drainage to that HUC14. Confirmatory testing (univariate logistic regression) showed the same result that only the total (cumulative) area for each HUC14 provided significant explanatory power regarding the response variable (probability of waterbody impairment). The conclusion from this non-spatial analysis that neither surface water discharges nor the land use/land cover profile are significant suggests that interference in the form of spatial autocorrelation may be present in the data. In the next section we present an analysis of spatial regression applied to the same data in an effort to uncover significant spatial patterns among the data.

Table 2. Non-spatial logistic regression results for full suite of explanatory variables for WMA06.

Nominal Logistic Fit for Impaired is 0

Whole Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	21.765694	5	43.53139	<.0001*
Full	9.023392			
Reduced	30.789086			

RSquare (U)	0.7069
Observations (or Sum Wgts)	46

Converged by Gradient

Lack Of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack Of Fit	40	9.0233922	18.04678
Saturated	45	0.0000000	**Prob>ChiSq**
Fitted	5	9.0233922	0.9989

Parameter Estimates

Term	Estimate	Std Error	ChiSquare	Prob>ChiSq	Lower 95%	Upper 95%
Intercept	-5.9704627	3.1049964	3.70	0.0545	-14.310258	-1.3466368
SWD_Count	0.05308263	0.1880363	0.08	0.7777	-0.4911161	0.40593425
Prop Cum Ag	6.46185834	17.194747	0.14	0.7071	-34.409336	39.3460785
Prop Cum Urban	11.4455525	7.4924866	2.33	0.1266	-2.211889	28.874951
Prop Cum IS	-39.994493	22.424615	3.18	0.0745	-97.160866	-2.4413312
CUM_ACRES	0.00070491	0.0003116	5.12	0.0237*	0.00026597	0.00151061

For log odds of 0/1

Effect Likelihood Ratio Tests

Source	Nparm	DF	L-R ChiSquare	Prob>ChiSq
SWD_Count	1	1	0.06899273	0.7928
Prop Cum Ag	1	1	0.13312184	0.7152
Prop Cum Urban	1	1	2.66906679	0.1023
Prop Cum IS	1	1	4.43459143	0.0352*
CUM_ACRES	1	1	37.0952881	<.0001*

Estimating Global Spatial Autocorrelation with the Moran's I Statistic

Regression and correlation techniques, especially ordinary least squares (OLS) are common empirical approaches to develop and investigate relationships between a response variable and one or more explanatory variables. However, these methods assume stationarity in space, which is often not a valid assumption for environmental data or any information with significant geographic (i.e., spatial) variability (Anselin 2005, Franczyk and Chang 2009, Nelson 2012). Examples include regional development (Yu and Wei 2007), distribution of crime (Fotheringham 2000), vegetation patterns and precipitation (Propastin et al. 2006), and occurrences of human health effects (Anselin 2005). Due to the natural heterogeneity and anisotropy of geographic-dependent data many traditional methods, such as OLS, for modeling the relationship will not provide accurate results. As shown previously, many researchers model the response of stream quality characteristics to explanatory watershed characteristics, such as land use/land cover, without the benefit of spatial regression techniques to account for likely spatial autocorrelation among the variables. Bockstael (1996) points this out regarding land use studies when she says, "A second econometric problem arises because we are admitting to the spatial relationship among observations. In both the hedonic model and the land use conversion model, we can expect that the omitted variables will be spatially correlated."

In the interest of parsimony, only spatial analysis and regression for WMA06 are presented. This section includes an analysis of global spatial autocorrelation among subwatersheds based on the probability of being impaired. The degree of global spatial autocorrelation in the land cover data for HUC14s in WMA06 was investigated using the global Moran's I (Yu and Wei, 2007). The global Moran's I statistic provides an estimate of the degree of spatial clustering (positive spatial autocorrelation, larger I) and spatially dissimilar areas (negative spatial autocorrelation, smaller I). The spatial weight matrix, which describes the linkage between spatial units (subwatersheds), is a key component in the calculation of spatial autocorrelation. For this investigation, six weighting strategies were tested: first-order queen contiguity, simple second-order queen continguity, cumulative second-order queen continguity, and three different distance-weighted matrices (3-, 5- and 10-mile [4.8, 8, and 16.1 km]). The software package GeoDa, developed by Anselin (2005), was used to investigate and model spatial autocorrelation among watershed characteristics and watershed impairment. Results of the global Moran's I calculations are shown in Table 4. Because Geoda does not have the ability to directly process binary response data, the logit transforms of the probabilities were used to represent the watershed impairment response (dependent) variable. Results from the weighting method sensitivity analysis indicate statistically significant positive spatial autocorrelation among the subwatersheds for the explanatory variables as well as the response variable. The second-order queen contiguity weighting strategy generally yielded less significant results and much lower values of the statistic I. The sensitivity analysis also showed that between 5-mile and 10-mile distance weighting there is a significant drop in the degree of spatial correlation between watersheds for all variables. The decrease in spatial correlation for 10-mile and second-order weighting schemes is expected given that the average HUC14 is only about 8.5 mi2 (22km2). Based on the sensitivity analysis results, standard (first-order) queen contiguity was used for the remainder of the analysis.

Figures 5 and 6 provide graphical examples of the global Moran's I results. Generally, the scatter plot indicates the overall Moran's I as the slope of the line through the data. The axes represent the variable of interest on the x-axis and the spatial lag of that variable on the y-axis. The graph indicates the spatial lag (measured in standard deviations) for each point on the scatter plot (i.e., for each subwatershed). Subwatersheds with low values for the given variable and where the spatial lag is also low (quadrant III), or where the values are both high (quadrant I) are considered to be positively spatially autocorrelated. Where the spatial lag and the variable have opposite directions (quadrants II and IV), these locations are said to exhibit negative spatial autocorrelation. The outliers (>2 std. dev.) in Figure 5 represent the most downstream subwatersheds, in other words, the subwatersheds with the largest cumulative drainage.

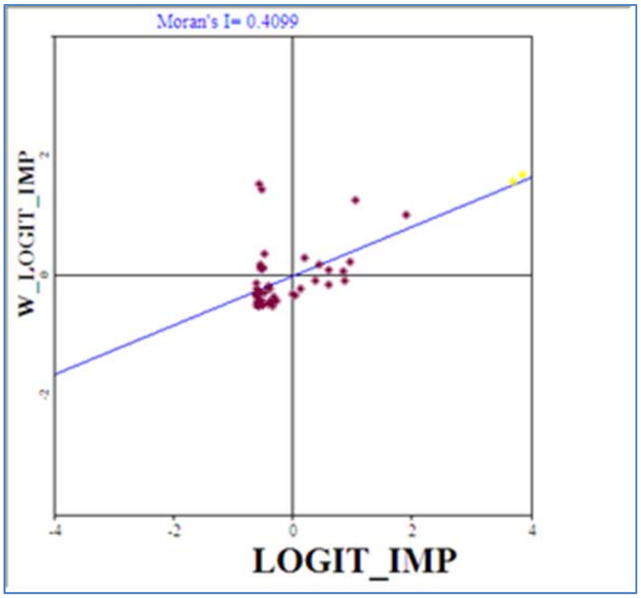


Figure 5. Scatterplot of Global Moran's I for Probability of Subwatershed Impairment

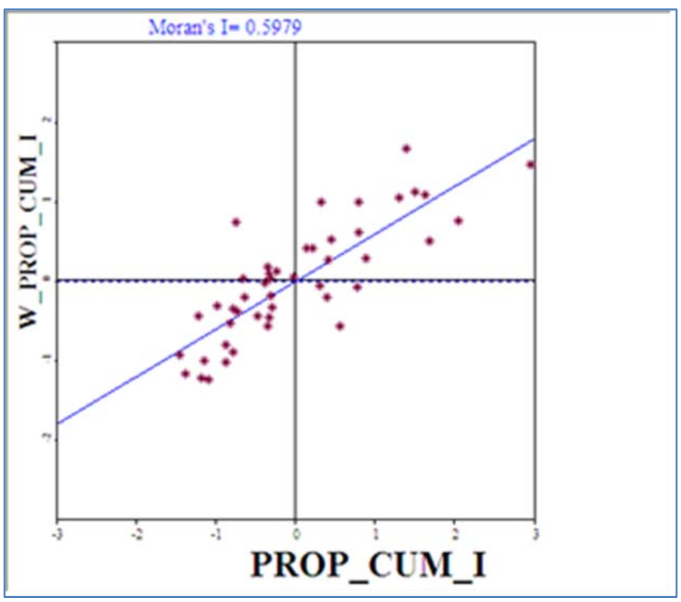


Figure 6. Scatterplot of Global Moran's I for Proportion of Impervious Surface

Investigating local patterns of subwatershed characteristics using local Moran's I and spatial regression

Since the standard queen contiguity spatial weight matrix strategy was shown to be as good or better than the others presented in the discussion on global Moran's I, this is the one that was used for the Local Index of Spatial Autocorrelation (LISA) analysis. The local Moran's I (Yu and Wei 2007) was used to explore local spatial autocorrelation among watershed variables in WMA06. Results of the univariate LISA analysis (performed with GeoDa software) indicated statistically significant local spatial autocorrelation for the same variables tested for global Moran's I (i.e., probability of impairment, cumulative drainage acres, proportion of agricultural and urban land cover and the proportion of impervious cover. Because the local Moran's I indicates local spatial autocorrelation between HUC14s, a map showing areas of WMA06 that exhibit significant (and at what level of significance) spatial autocorrelation can be developed from the calculations. Figure 7 presents a LISA significance map for the proportion of urban land in the cumulative drainage basin for each subwatershed. To fully comprehend the significance map one should also look at the LISA cluster map for the same variable. Figure 8 shows clusters of HUC14s where there is positive (high-high or low-low) spatial autocorrelation for proportion of urban land cumulatively contributing to the subwatershed one HUC14 indicating negative (low-high) spatial autocorrelation. This cluster map matches well with our expectations given that the area of high-high positive spatial autocorrelation are areas of denser development, such as Morristown, Parsippany, Florham Park, Hanover, New Jersey. The areas indicated as low-low correspond to rural and forested areas of northern Morris County and Sussex County.

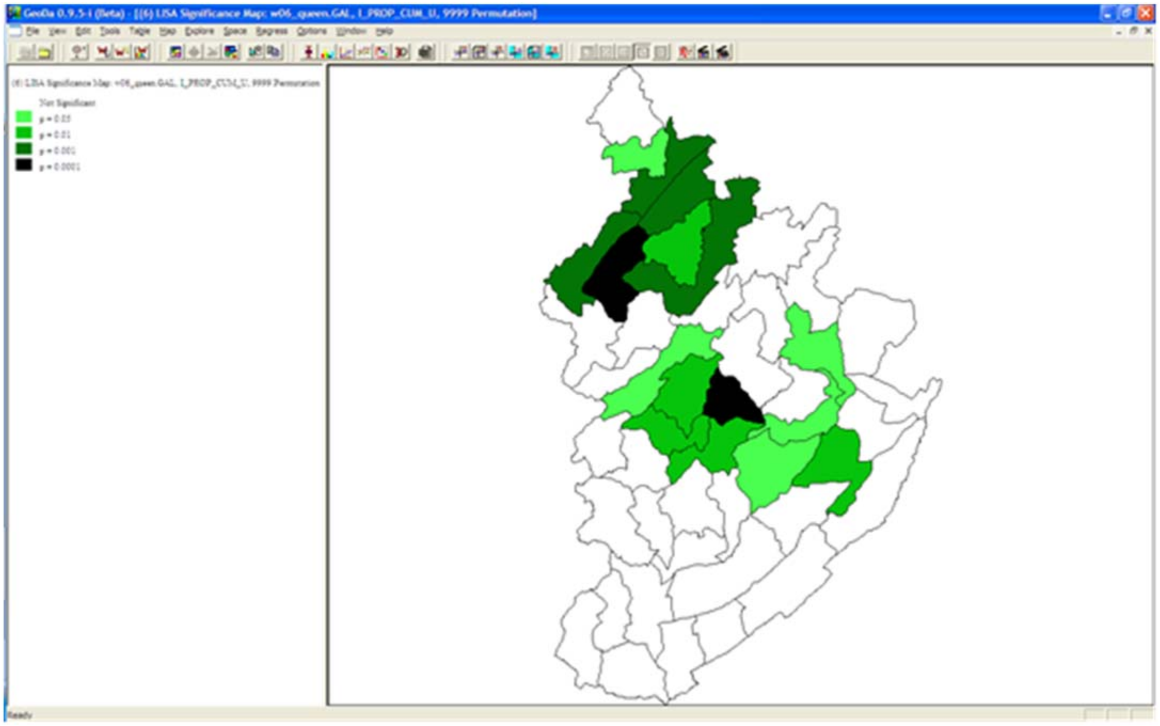


Figure 7. LISA significance map for proportion of urban land in cumulative drainage area for subwatersheds in WMA06

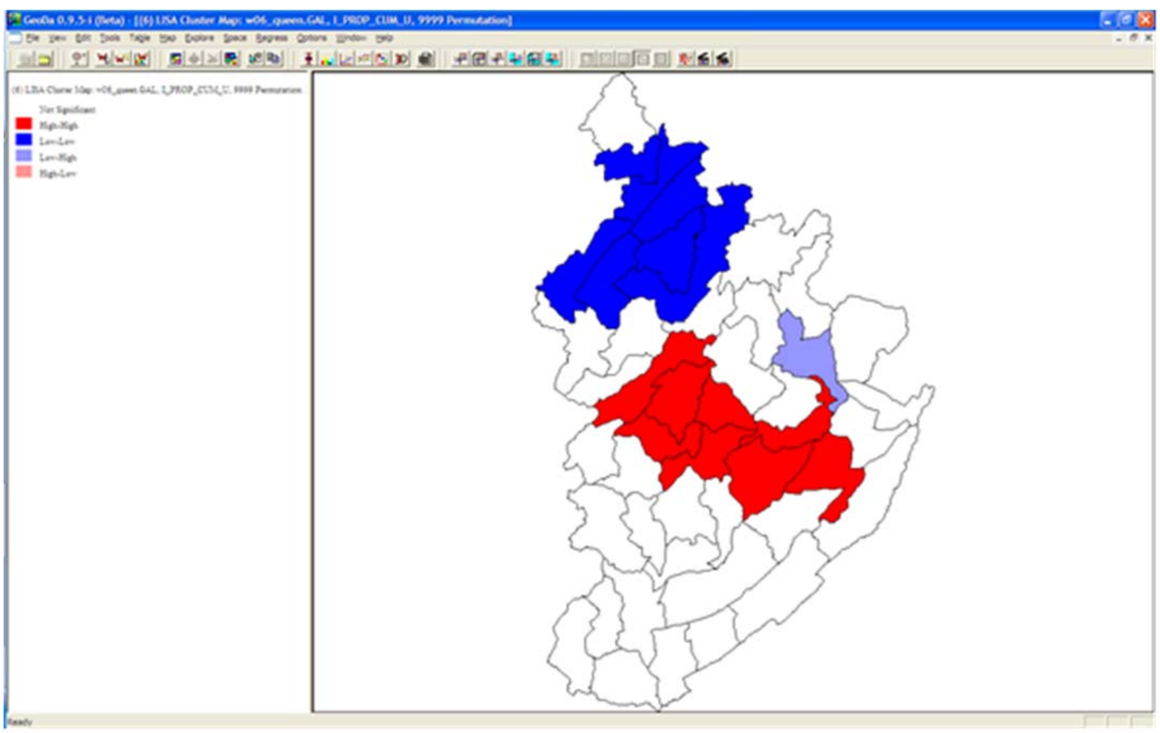


Figure 8. LISA cluster map for proportion of urban land in cumulative drainage area for subwatersheds in WMA06

Conclusions

In 2006, New Jersey further embraced the watershed approach for managing water quality by redefining the spatial extent for surface water assessment units. The old approach was to extrapolate data from point monitoring locations to stream reaches. The new approach is to extrapolate data collected at point sampling locations to HUC14 subwatersheds. This dramatic change in spatial extent of the reported assessment unit affords an opportunity to explore relationships between broad basin characteristics, such as land use/land cover, and surface water quality impairment; and to use new tools for characterizing the spatial nature of those relationships.

In this instance, GIS-based spatial analysis was compared to ordinary least squares regression, a traditional statistical approach. The investigation presented in this paper shows the importance of applying the correct statistical approach to match the relevant decision-making data. In this case, nominal (binary) data defines the decision criteria (the response variable), and so logistic regression techniques were used for analyzing potential explanatory data. As data for many of the relevant potential impacts to surface water quality (e.g., surface water discharge, land use/land cover, impervious surface, and drainage area) are already organized by watershed in New Jersey, the new spatial extent creates an improved nexus between the reporting unit and the likely drivers of water quality impacts. In this case spatial analysis showed that correlations exist between land use and impaired waterbodies at the subwatershed scale that were not apparent using ordinary non-spatial regression techniques.

The model specification used the proportion of various land use/land cover types (agriculture, urban, cumulative drainage area, and impervious surface) as explanatory variables related to impaired watersheds. Although similar relationships have been described in the literature previously, as noted, they did not attempt a rigorous analysis of spatial dependence. In this case study, these predictors of water quality impairment were shown to be highly spatially dependent, as measured by the Moran's I statistic, both for the larger Watershed Management Area, as well as locally between subwatersheds. This has important implications for two aspects of watershed management: source identification and managing costs for water quality assessment activities. First, a model that includes the effects of spatial dependence may provide a clearer indication of the sources of contamination (especially non-point) causing impairments. Second, a spatially infused model may provide a statistically valid (and less costly) approach for monitoring and assessment of waterbodies.

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