

## Does Rural Job Growth Lead the Economy Out of Recession?

Alla Golub

Jason Henderson

and

Ken Foster\*

Dept. of Agricultural Economics  
Purdue University  
403 W. State Street  
West Lafayette, Indiana 47907-1145  
Phone: (765) 494-0593  
Fax: (765) 494-9176  
golub@purdue.edu  
Jason.Henderson@kc.frb.org  
kfoster@purdue.edu

\*The authors are Ph.D. student in the Department of Agricultural Economics, Purdue University; Economist in Center for the Study of Rural America, Federal Reserve Bank of Kansas City; and professor in the Department of Agricultural Economics, Purdue University, respectively.

**Paper prepared for presentation at American Agricultural Economics  
Association Annual Meeting, Denver, Colorado, August 1-4, 2004**

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Alla Golub  
Purdue University

Jason Henderson  
Center for the Study of Rural America, Federal Reserve Bank of Kansas City

Ken Foster  
Purdue University

### *Abstract*

This paper explores the dynamics of rural and non-rural job growth to investigate if job growth starts in rural places, making it one of the leading indicators of economic growth. Empirical results provide mixed evidence. The mixed results of the Granger non-causality tests could be sensitive to the non-rural area definition. The relationship between rural job growth and non-rural job growth is not restricted to post-recession periods. Analysis of Bureau of Labor Statistics data suggests the spillover effects of non-rural growth are larger than the spillover effect of rural growth on non-rural areas. But this positive response of rural growth disappears over time and turns sharply negative. In the long run, “backwash” effects outweigh “spread” effects.

Keywords: rural job growth, business cycle, VAR model.

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### **Introduction**

Vibrant, dynamic, and pace-setting growth is not the common stereotype of economic activity in rural places. The stereotype of rural America is often a picture of the sleepy, one gas station town with empty storefronts and dwindling populations. Successful rural communities are those that are no longer rural. This rural stereotype is supported by the fact that rural areas posted slower growth in terms of employment and population than metro areas.<sup>1</sup> Between 1970 and 2001, rural employment rose 2.2 percent per year compared to 2.9 percent in metro areas.<sup>2</sup> During the same time frame, rural populations expanded 1.1 percent per year compared to 1.6 percent in metro areas.

Therefore, it is quite surprising to find that rural areas have posted stronger job growth during the initial parts of the economic recoveries after the 1991 and 2001 recessions (Chart 1). Between 1992 and 1995 rural job growth was stronger than non-rural job growth. After the 2001 recession, rural job growth, that fell more sharply than non-rural job growth, surged past metro job growth during 2002.<sup>3</sup> This phenomenon appears not to be just a recent occurrence. Rural job growth was stronger than the rest of the nation after the 1970 and 1974 recessions (Henderson, 2002).

This paper explores the dynamics of rural and non-rural job growth to investigate if job growth starts in rural places, making it one of the leading indicators of economic growth. Given the job growth patterns in Chart 1, the paper will investigate the causal relationship between rural and non-rural job growth. The paper will also explore whether this relationship is restricted to post-recession recoveries or if it holds throughout business cycles.

## **Literature**

Recent literature examining the dynamic relationship between rural and non-rural employment is limited. Regional economists have explored rural growth. Most of the research on rural growth, however, has concentrated on analyzing the local factors that influence rural employment or income growth (Barkley, Henry, and Kim; Deller, et. al.; Henry, Barkley, and Bao; Henry and Drabenstott; Goetz and Rupasingha; Rupasingha, Goetz, and Freshwater). In these models, proximity to metro areas is often included to measure the impact of metro spillovers on rural growth. Barkley, Henry and Bao (1996) analyze the spatial “spread” and “backwash” effects of metro population growth on rural population growth.

Economic literature exploring regional business cycles is sparse, with no analysis directed at rural business cycles. Most of the research on regional business cycles is targeted at the state level. Partridge and Rickman analyzed state level business cycles to determine if regional business cycles have disappeared in the new economy. Mills and DeFina examined the varied regional impacts of monetary policy across U.S. states. Smith analyzed the relationship between job growth in the U.S. and states in the Tenth Federal Reserve District. This paper expands the literature by looking at rural business cycles and the dynamic relationship between rural and non-rural employment growth.

## **Methodology**

A two-equation vector autoregression (VAR) model is employed to explore the relationship between job growth in rural and non-rural areas. A VAR model allows for the testing of our hypotheses that rural job growth leads non-rural job growth. The system of two dynamic equations is:

$$y^r_t = \alpha^r + \gamma_1 y^{nr}_{t-1} + \dots + \gamma_p y^{nr}_{t-p} + \delta_1 y^r_{t-1} + \dots + \delta_p y^r_{t-p} + \varepsilon^r_t \quad (1)$$

$$y^{nr}_t = \alpha^{nr} + \theta_1 y^{nr}_{t-1} + \dots + \theta_p y^{nr}_{t-p} + \varphi_1 y^r_{t-1} + \dots + \varphi_p y^r_{t-p} + \varepsilon^{nr}_t \quad (2)$$

where  $y_t$  is job growth at time  $t$  and superscripts  $r$  and  $nr$  denote rural and non-rural respectively. Analysis begins by identifying the dynamics of the rural and non-rural data series. Then, the maximum order  $P$  of VAR process is specified. Finally, to obtain a more parsimonious model, sequential procedures with likelihood ratio test and Akaike's information criterion (AIC) are used to reduce the number of lagged dependent variables in the system of equations (Judge et. al), and thus multicollinearity is reduced.

### Data

To analyze the causality between rural and non-rural job growth, monthly data between 1990 and 2003 are obtained from the Bureau of Labor Statistics (BLS) Current Employment Statistics (CES) program, commonly referred to as the payroll survey.<sup>4</sup> Total non-farm job levels are obtained at the state and metro levels. Non-rural jobs are defined as the sum of metro jobs for all metro areas with data reported beginning in 1990. Rural jobs are defined as the difference between total state level jobs and non-rural jobs. Monthly rural and non-rural job growth in period  $t$  is defined as the percent change from year ago,  $\text{growth}_t = (\text{job}_t - \text{job}_{t-12})/\text{job}_{t-12}$ . The annual percent change is used to control for monthly seasonal factors that may be different in metro and rural areas. The data was presented in Chart 1.

It is important to keep in mind that this data comes from payroll survey. The payroll survey data is based on existing establishments. One drawback of the payroll survey is that it does not reflect new business start-ups and are thought to understate employment gains during recoveries when new business start-ups are higher. The alternative would be household survey data that come from a survey of individuals. However, household survey would be less precise than payroll survey and economists commonly follow the payroll

survey in measuring employment growth (Schreft and Singh, National Bureau of Economic Research).

### **Empirical Estimation**

Estimation begins by testing for stationarity of the rural and non-rural employment growth time series with the Augmented Dickey-Fuller (ADF) test. The lag lengths for the ADF tests were chosen to ensure that errors are uncorrelated. The null hypothesis for unit root test is that the considered series are nonstationary. As reported in Table 1, the test suggests that rural and non-rural job growth time series are not stationary in levels, but are stationary in first differences. That is, they can be treated as integrated of order one which is commonly written: I (1).

Having established the order of integration of each series, we proceed to test for cointegration. The two-step residual-based procedure for testing the null of no cointegration following Engle and Granger was employed.<sup>5</sup> The following two regressions should be estimated in this approach:

$$y_t^{nr} = a + by_t^r + v_t \quad (3)$$

$$\Delta v_t = \alpha_0 + \alpha_1 v_{t-1} + \sum_{i=1}^l \gamma_i \Delta v_{t-i} + \omega_t \quad (4)$$

where  $\omega_t$  is assumed to be white noise. The number of lagged terms  $l$  is chosen to whiten the errors. We fail to reject the null of no cointegration between rural and non-rural job growth.<sup>6</sup> This finding is unexpected because it means that there is no long-run equilibrium relationship between rural and non-rural job growth evident in the time series under investigation.

To investigate whether rural job growth causes non-rural job growth we apply the Granger causality tests to not cointegrated series (Smyth and Nandha). We estimate a VAR(P) in first differences model:

$$\Delta y^r_t = \alpha^r + \gamma_1 \Delta y^{nr}_{t-1} + \dots + \gamma_p \Delta y^{nr}_{t-p} + \delta_1 \Delta y^r_{t-1} + \dots + \delta_p \Delta y^r_{t-p} + v^r_t \quad (5)$$

$$\Delta y^{nr}_t = \alpha^{nr} + \theta_1 \Delta y^{nr}_{t-1} + \dots + \theta_p \Delta y^{nr}_{t-p} + \phi_1 \Delta y^r_{t-1} + \dots + \phi_p \Delta y^r_{t-p} + v^{nr}_t \quad (6)$$

where  $\Delta y_t$  is the first difference of growth. The maximum implied univariate lag order is  $m \cdot P = 12^7$ ,  $m = 2$  is number of series and  $P$  is lag order of the VAR model. So,  $P = 12/2 = 6$ . Starting from a maximum lag order 6 of VAR, the lag length was selected that minimizes AIC to create a more parsimonious model by decreasing the order of the AR process. The AIC is minimized at lag length 4, and the model's errors are uncorrelated (based on Ljung-Box-Pierce test statistics) and homoskedastic (based on White's test). The results are presented in Table 2.

The results of Table 2 are used to test for causality between rural and non-rural job growth. For non-rural growth to not Granger-cause rural employment growth,  $\sum \gamma_j = 0$  in equation 5 and for rural growth to not Granger – cause metro growth,  $\sum \phi_j = 0$  in equation 6. The hypothesis that non-rural job growth does not Granger-cause rural job growth cannot be rejected. The hypothesis that rural job growth does not Granger-cause non-rural job growth is rejected. Based on results of these tests, we conclude that there is uni-directional causality running from rural employment growth to metro employment growth.

### **Is this a Jobless Recovery Phenomena?**

The preceding results indicate that rural job growth leads non-rural growth between 1991 and 2003. But, does this relationship hold for longer periods of time? The recoveries following the 1991 and 2001 recessions were “jobless” recoveries. Schreft and Singh indicate that the job growth during the “jobless” recoveries were structurally different than previous recoveries.

Additional analysis using an alternative source of monthly data from 1972 to 2003 is used to explore the consistency of the previous finding beyond the “jobless” recoveries. In

this section, data used in the empirical analysis differ from previous data sets due to the definition of non-rural. Non-rural jobs are defined as jobs reported in U.S. cities starting in 1970 with job levels greater than 50, 000 people on January 1972. Rural jobs are the difference between the sum of state level total jobs and non-rural jobs. The data exclude the state of Washington because of reporting problems for this state in the 1980s. This data is also derived from the payroll survey.<sup>8</sup> Job growth is again defined as a percent change from year ago and presented in Chart 2.

There are two potential problems with the data surrounding apparent abnormal deviation from the series. A spike occurs in the 2003 numbers beginning in January 2003 (Chart 2). Therefore, we exclude 2003 data from the analysis. Second, there appears to be a break in the series in 1988 (Chart 2). There are two possible explanations for this break. First, BLS benchmarks the data each year, but sometimes they do not do it for all of the previous years. Second, BLS could redefine metro boundaries. To smooth the effect of this break on the estimation, Equations 1 and 2 are modified to include a dummy variable representing 1988. Equations 7 and 8 represent the system of two dynamic equations:

$$y^r_t = \alpha^r + \gamma_1 y^{nr}_{t-1} + \dots + \gamma_p y^{nr}_{t-p} + \delta_1 y^r_{t-1} + \dots + \delta_p y^r_{t-p} + b^r break + v^r_t \quad (7)$$

$$y^{nr}_t = \alpha^{nr} + \theta_1 y^{nr}_{t-1} + \dots + \theta_p y^{nr}_{t-p} + \phi_1 y^r_{t-1} + \dots + \phi_p y^r_{t-p} + b^{nr} break + v^{nr}_t \quad (8)$$

where *break* is the dummy variable representing 1988.

### *Empirical Estimation*

First, we test for stationary of the rural and non-rural growth time series with an ADF test. Unit root test (see Table 3) suggests metro and rural employment growth time series are stationary at levels (I (0)).

To identify the appropriate autoregressive (AR) process, a two-equation vector autoregression (VAR) model is specified. If the true process is vector autoregressive moving average (VARMA), then the order P of the corresponding VAR process is infinite. The



truncation of infinite sequence at lag P is possible if only negligible part of the model is left beyond lag P.

The maximum lag order P of VAR model is 6 (P=12/2, where 12 is order of autoregressive order of univariate series<sup>9</sup> and 2 is number of series). Starting from maximum lag order 6, AIC information criteria is used to specify a more parsimonious model. Based on these tests, the lag length 4 is chosen. However, based on Ljung-Box-Pierce test statistics, none of the considered VAR (p = 6, 5, 4) models gives white noise errors. Autocorrelation function and partial autocorrelation function plots reveal significant autocorrelations at lag 12. Inclusion of larger number of lags or variable representing autocorrelation in errors does not help to overcome the problem. However, an inclusion of a moving average term at lag 12 in equations (7) and (8) allows us to obtain white noise errors. The appropriate model to describe the dynamics of rural and non-rural job growth is VARMA (6,12) with nonzero parameters at q = 12 and p = 1...6 :

$$y^r_t = \alpha^r + \gamma_1 y^{nr}_{t-1} + \dots + \gamma_6 y^{nr}_{t-6} + \delta_1 y^r_{t-1} + \dots + \delta_6 y^r_{t-6} + b^r break + v^r_t + a^r v^r_{t-12} \quad (9)$$

$$y^{nr}_t = \alpha^{nr} + \theta_1 y^{nr}_{t-1} + \dots + \theta_6 y^{nr}_{t-6} + \phi_1 y^r_{t-1} + \dots + \phi_6 y^r_{t-6} + b^{nr} break + v^{nr}_t + a^{nr} v^{nr}_{t-12} \quad (10)$$

The sequential testing procedure is used to determine the order of AR process.<sup>10</sup> Based on the results of the likelihood ratio test shown in Table 4, the appropriate order of autoregressive process is p=4.

The final model specification is VARMA (4,12) with nonzero parameters p=1, 4 and q=12.<sup>11</sup> The sample is divided into in-sample (3/4) and out-of-sample (1/4) parts. The final model is chosen based on in-sample estimation and then validated on the out-of-sample subset. This model performs very well for the non-rural growth rate series in out-of-sample ( $R^2 = 0.98$ ), but not so well for rural growth rate series ( $R^2 = 0.78$ ). The parameters of the final model, estimated on the whole sample, are shown in Table 5.

If rural growth leads non-rural growth, the negative significant coefficient at variable  $rural(t-4)$  in the non-rural equation is unexpected. One possible explanation is that it could be a correction relative to the positive first lag of rural. Another explanation is multicollinearity. Further examination suggests that the negative sign of the coefficient at variable  $rural(t-4)$  in the non-rural equation is due to multicollinearity and past rural job growth has positive effect on the non-rural job growth.<sup>12</sup>

Now, Granger-causality tests can be employed on the model results. Similar to previous findings, the testable null hypothesis that rural growth does not Granger-cause non-rural growth is rejected. Also, the null hypothesis that non-rural growth does not cause rural growth is also rejected. Given the multi-directional causality, we are unable to determine if job growth starts in rural areas.

Coefficients reported in Table 5 can be used to calculate dynamic multipliers to analyze the impacts of non-rural growth on rural growth and vice versa. The dynamic multipliers show the effect of the one-unit shock in the independent variable  $s$  periods in the past on the current level of the dependent variable (Hamilton). The long-run multiplier shows the cumulative effect of the shock to the independent variable infinite number of periods ago on the current level of the dependent variable. The system of equations (9) and (10) can be augmented to first order following Hyde and Foster:

$$\hat{y}_t = \mu + P\hat{y}_{t-1} + A * v_{t-12} + v_t \quad (11)$$

where  $\hat{y}_t$  and  $\hat{y}_{t-1}$  are vectors of dependent and independent variables respectively, augmented to include the state variables. Matrix P is 8x8 with autoregressive coefficients from Table 5 in the first two rows and ones and zeros in other 6 rows. Eigenvalues of matrix P are less than one in absolute value, so the system represented in (9) and (10) with coefficients given in Table 5 is stable. Matrix A is 8X8 with moving average coefficients in the first two rows and

zeros in other 6 rows. The effect of the shock  $s$  periods in the past in endogenous variables on other endogenous variable is:

$$\frac{\partial E y_t}{\partial v_{t-s}} = P^s \text{ when } s < 12 \text{ and} \quad (12)$$

$$\frac{\partial E y_t}{\partial v_{t-s}} = P^{s-12}(A + P^{12}) \text{ when } s \geq 12. \quad (13)$$

The long run multiplier for a pair of endogenous variables is the sum of dynamic multipliers for these two variables over time. The dynamic and long run multipliers can be converted to dynamic elasticities by multiplying them by ratio of means of the appropriate endogenous variables. The graphs of dynamic elasticities of non-rural job growth with respect to rural job growth and dynamic elasticities of rural job growth with respect to non-rural job growth are shown in Chart 3.

The dynamic elasticities indicate that the response of rural job growth to a shock in non-rural growth is stronger and faster than response of non-rural job growth to a shock in rural job growth in a positive direction during the initial periods immediately after a shock. However, the initial positive response of rural job growth may be offset by the subsequent negative effect such that the overall long run response is zero (or even negative). In contrast, the response of non-rural job growth is positive initially with subsequent small negative effect. So, the long run response of non-rural job growth to a shock in rural growth may be positive. These conclusions are supported by long-run dynamic elasticities: the subsequent large negative effect on rural job growth leads to a negative (-10.1) long-run elasticity of rural job growth. In contrast, long – run elasticity of non-rural job growth is 26.2.

The dynamic multipliers are consistent with many general implications that have emerged from studies analyzing rural growth on a cross-sectional basis. A general finding of these studies is that metro areas produce spillover effects on nearby rural places.<sup>13</sup> The finding that the elasticity of rural is larger than the elasticity of non-rural is consistent with

the finding that the spillovers from non-rural on rural places is larger than the spillovers from rural on non-rural places.

The switching of the dynamic multipliers from a positive to negative value is also consistent with past literature that has analyzed the “spread” and “backwash” effect of metro growth on rural growth.<sup>14</sup> Barkley, Henry, and Bao (1996) analyze the “spread” and “backwash” effects of metro areas on rural hinterlands in terms of population growth. They find that both “spread” and “backwash” effects are present in most circumstances, but that the net result depends on the characteristics of the rural community. The estimated dynamic multipliers suggest that the net effects arising from “spread” and “backwash” vary over time. In the initial periods after a shock to non-rural job growth, “spread” effects dominate. But over time, “backwash” effects dominate. While initial non-rural job growth can cause job growth to spread to rural places, over time non-rural growth attracts activity from rural places.

Moreover, these findings may help explain the contradiction highlighted during the introduction that over the long term, rural employment and population growth is slower than non-rural growth despite the fact that rural areas have led growth out of recoveries. Over time, “spread” effects give way to “backwash” effects. Relative growth between rural and non-rural locations varies on the time horizon of the analysis.

Finally, industry or occupational job mix could be driving the directional change of the dynamic multipliers. In analyzing the regional dynamics of the business cycle, Carlino and DeFina (1999) indicate that variations in the industry mix can cause business cycles to vary across states. Variations in industry mix could be causing the differences in rural and non-rural dynamic multipliers.

The different dynamic paths could also be a function of the occupational mix of jobs in rural and non-rural locations. Rural locations have higher concentrations of low-skilled

occupation and lower concentrations of high-skilled occupations compared to their non-rural counterparts (Wojan, 2000). If the volatility or timing of job losses or additions varies by occupational mix, then overall job growth of rural and non-rural places could vary by occupational mix. For example, lower-skilled production workers are often the first to be laid-off before managers during economic downturns and the first to be hired during economic recoveries. Given the different concentrations of skill levels in rural and non-rural places, the dynamic multipliers could be identifying the initial expansion of low-skilled workers that often occurs in rural places to a shock to non-rural growth. In the longer term, the expansion of managers or other high-skilled workers, often in non-rural locations, takes place and dominates low-skilled job growth.

Moreover, while economic recoveries lead to expansion in all types of occupations (low and high-skilled), over the long-run we know that low-skilled job growth is slower than high-skilled job growth in the U.S. (Henderson, 2004). Thus, the short-run versus long-run multipliers present in rural places may reflect the changes in low-skill, high-skill occupations. For example, after a non-rural shock, spillovers can produce growth in rural places. But this growth may be low-skilled activity, causing high-skilled workers to migrate to non-rural locations with larger concentrations of high-skilled jobs. Since growth of high-skilled jobs is outpacing low-skilled jobs, the migration from rural to non-rural should increase over time and thus contribute to the long-run negative multiplier.

### **Do the impacts vary according to the business cycle?**

Graphical depictions of rural and non-rural job growth in Charts 1 and 2 indicate that the relationships between rural and non-rural growth may vary according to the business cycle. For example, following the 1991 recession rural growth was stronger than non-rural growth for almost 3 years before falling below non-rural growth for the rest of the 1990s. To test

whether the rural growth affects non-rural growth in post-recovery periods only, equation (10) is modified to the following:

$$y^{nr}_t = \alpha^{nr} + \theta_1 y^{nr}_{t-1} \dots + \theta_p y^{nr}_{t-p} + \varphi^+_1 y^{r^+}_{t-1} + \dots + \varphi^+_p y^{r^+}_{t-p} + \varphi^-_p y^{r^-}_{t-p} + b^{nr} break + v^{nr}_t + a^{nr} v^{nr}_{t-12} \quad (14)$$

where  $y^{r^+}_{t-i} = y^r_{t-i}$  if  $t-i$  is in a recovery period and 0 otherwise, and  $y^{r^-}_{t-i} = y^r_{t-i}$  if  $t-i$  is not in a recovery period and 0 otherwise. Recovery is defined as the 24 months following the trough of the recession as defined by National Bureau of Economic Research (NBER). In cases when another recession has started before 24-month mark, recovery is defined as a time period between trough and next peak (see Table 6).

The sign and significance of  $\varphi^+_i$  are used to analyze the effect of rural growth on non-rural growth over the recovery period. The coefficient estimates, presented in Table 7, are very similar to and consistent with the results reported in Table 5.

The null hypothesis that rural growth does not impact non-rural growth during recoveries,  $\varphi^+_1 = \varphi^+_4 = 0$ , is rejected at 95% confidence level.<sup>15</sup> Also, the hypothesis that rural growth does not affect non-rural growth in all other periods not defined as recovery ( $\varphi^-_1 = \varphi^-_4 = 0$ ), is also rejected.<sup>16</sup> When equation (9) is modified similar to (10) and hypotheses about effects of non-rural growth on rural growth are tested, similar results are obtained. The effect of non-rural growth on rural growth is restricted neither to the post-recession periods, nor to all other periods. Redefinition of recovery as 12 month period following the trough of the recession does not change the conclusions above.

## Conclusions

This paper investigated the interaction between rural and non-rural job growth to determine if job growth starts in rural places. Empirical results provide mixed evidence. Analysis of BLS payroll survey data from 1990 to 2003 found uni-directional causality running from rural job

growth to non-rural job growth, evidence that job growth could start in rural places.

However, analysis of the BLS payroll survey data from 1972 to 2003 was unable to conclude if job growth starts in rural places because, multi-directional causality was found between rural and non-rural job growth.

Analysis of BLS data from 1972 to 2002 suggests that the initial response of rural job growth to a non-rural job growth shock was stronger and faster than the response of non-rural job growth to a rural job growth shock. In other words, the spillover effects of non-rural growth are larger than the spillover effect of rural growth on non-rural areas. But this positive response of rural growth disappears over time and turns sharply negative. In the long run, “backwash” effects outweigh spillover or “spread” effects.

Third, the relationship between rural job growth and non-rural job growth is not restricted to post-recession (recovery) periods. In the short run, the magnitude and sign of the effect of rural on non-rural depends on the lag, not on the period of business cycle. The same can be said about the effect of non-rural job growth on rural job growth.

Evidence that job growth starts in rural places is mixed. The mixed results of the Granger non-causality tests could be sensitive to the non-rural area definition. Ongoing research is addressing this issue by analyzing Granger causality between rural and non-rural employment growth based on household survey. This data is available on a county level for 1990-2003 from BLS Local Area Unemployment Statistics. The availability of county level data would allow for varying definitions of rural and non-rural to check for the robustness of the results across rural definitions.

Moreover, the household survey data come from a survey of individuals and includes agricultural and self-employed workers, while the payroll survey data is based on existing establishments. Inclusion of household survey data would allow checking the robustness of the empirical results across different measures of employment. However, the household data

is based on place of residence not on the place of work. Therefore, the commuting of rural (non-rural) workers to non-rural (rural) areas could limit the ability to check for robustness.

Analysis using the household data could also determine if the dynamic multipliers vary by community size. Barkley, Henry, and Bao (1997) analyze the “spread” and “backwash” effects of metro population growth on rural hinterland growth. They find that the effects vary by the size and proximity of the rural place to a metro area. Thus, analysis on a rural and non-rural basis may be too large of an aggregate to truly understand where job growth starts. Job growth may not start in all rural places, but in selected rural places with specific characteristics. Future research will help determine if job growth starts in communities of specific size.



## Footnotes

<sup>1</sup> In this paper, rural is equated with non-metro and is not reflective of the traditional Census definition.

<sup>2</sup> Calculations based on BEA, Regional Economic Information System (REIS) data.

<sup>3</sup> A similar patten emerges when using data from the BLS household survey.

<sup>4</sup> Data was restricted to 1990 because that was the earliest monthly data, BLS provided upon request.

<sup>5</sup> The Johansen and Juselius approach can also be used to test for cointegration if the data come from a normal distribution. Normality is rejected for both rural and non-rural job growth series. Only the Engle and Granger approach is used to test for cointegration.

<sup>6</sup> Engle-Granger t-statistic is -1.55. The 10% critical value for this test is -3.04.

<sup>7</sup> Because of monthly data, the implied order of univariate time series is 12.

<sup>8</sup> It is uncertain how the different definitions of non-rural and rural would alter the results. It would depend on the causality between medium-sized places and other areas. For example, if medium-sized places actually Granger-caused growth in other locations, categorizing them in rural would cause rural to Granger-cause non-rural or vice-versa.

<sup>9</sup> Again, for univariate time series we choose maximum lag order 12 because the data that we use is monthly data.

<sup>10</sup> The likelihood ratio test statistic is asymptotically  $\chi^2$  distributed with  $k^2(n-l)$  degrees of freedom, where  $k$  is number of series,  $n$  is maximum order specified and  $l$  is order which should be tested against  $n$ .

<sup>11</sup> VARMA (4, 12) with nonzero parameters  $p=1..4$  and  $q=12$  was estimated with maximum likelihood (ML) procedure. In both equations the coefficients at rural and metro growth rates at lags 2 and 3 are not significantly different from zero. Another likelihood ratio test was conducted to test whether VARMA(4,12) with nonzero parameters  $p=1, 4$  and  $q=12$  can be

specified. The likelihood ratio test statistic is 9.85 with p-value 0.28. The hypothesis that coefficients are zero at lags 2 and 3 cannot be rejected.

<sup>12</sup> To examine the possibility of multicollinearity, the model was estimated without *rural(t-1)* in the non-rural equation. The coefficient of *rural(t-4)* became small, positive and insignificant (coefficient is 0.0006 with p-value = 0.94). When *rural(t-4)* is dropped from equation, the coefficient at *rural(t-1)* remains positive and significant (0.018 with p – value = 0.05). In the rural equation, the coefficients of *non-rural(t-1)* and *non-rural(t-4)* are similar in magnitude but opposite in sign. When they are dropped from rural equation, one at time, the coefficient at *non-rural(t-4)* stays negative but insignificant (p-value = 0.18). The coefficient at *non-rural(t-1)* becomes negative and insignificant.

<sup>13</sup> Studies analyzing rural growth with cross-sectional data often include a proximity to metro locations as an explanatory variable to capture spillover effects of metro areas on rural places.

<sup>14</sup> “Spread” effects occur when growth in a non-rural (rural) location leads to positive growth in a rural (non-rural) location. “Backwash” effects occur when growth in a non-rural (rural) location is associated with negative growth in a rural (non-rural) location.

<sup>15</sup> The likelihood ratio statistic was 6.7 with a p-value 0.0352.

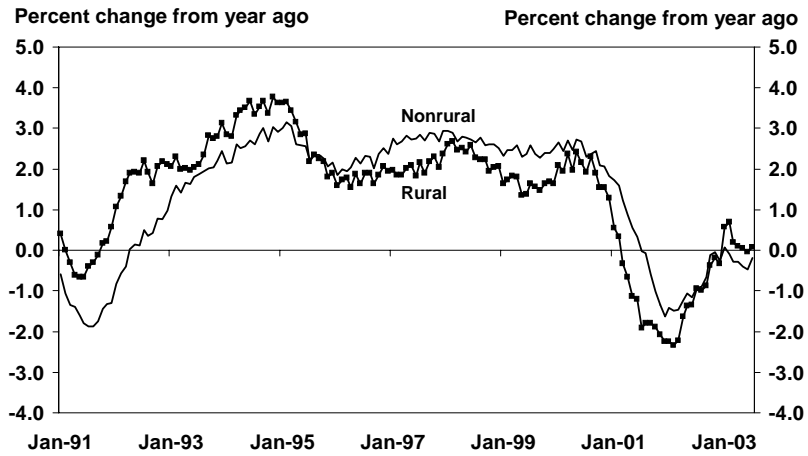
<sup>16</sup> The likelihood ratio statistic was 9.5 with a p-value = 0.0087.

## References

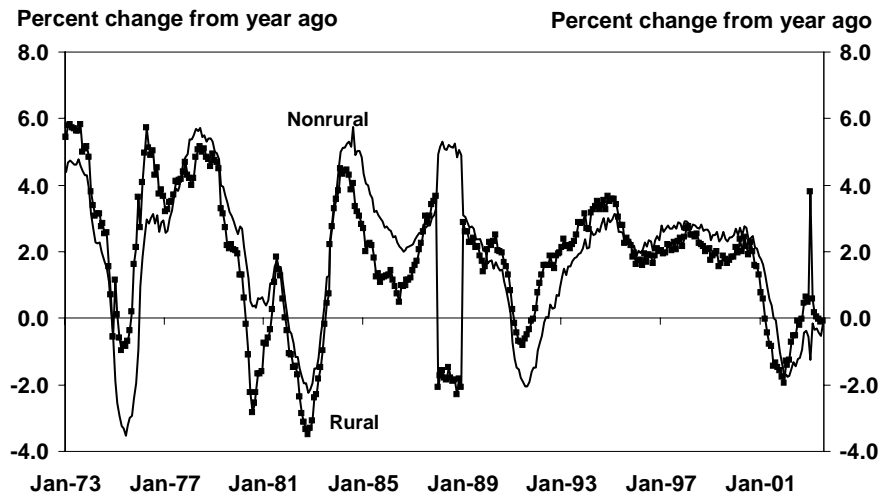
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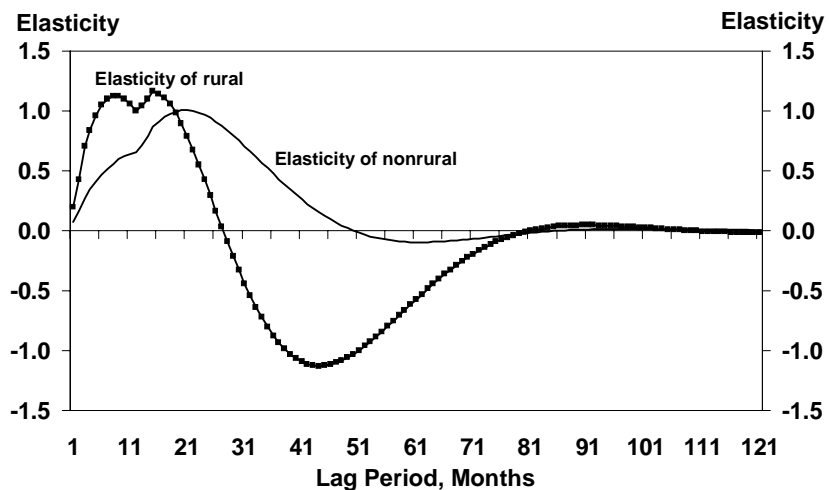
**Chart 1: Rural and Non-rural Job Growth, 1990-2003**



**Chart 2: Rural and Non-rural Job Growth, 1972 - 2003**



**Chart 3: Dynamic Elasticities of Rural (Non-rural) Job Growth with Respect to Non-rural (Rural) Job Growth**



**Table 1. Unit Root Results for Rural and Non-rural Job Growth, 1990 - 2003**

Variable	Levels	First difference
Rural growth	-0.99	-5.05*
Nonrural growth	-1.44	-3.68*

Data from BLS payroll survey, 1990-2003.

\*Significant at 10% critical value is -2.57

**Table 2. Coefficient Estimates for VAR(4). Rural and Non-rural Job Growth.**

Variable	Non-rural equation coefficients	Rural equation coefficients
constant	0.009	-0.001
non-rural (t-1)	0.041	-0.103
non-rural (t-2)	0.011	-0.080
non-rural (t-3)	0.357***	0.361*
non-rural (t-4)	-0.130	-0.209
rural(t-1)	-0.143*	-0.153
rural (t-2)	0.135*	0.170
rural (t-3)	0.143*	0.190*
rural (t-4)	0.192**	0.267**
MSE	0.031	0.060
R-square	0.332	0.243
White's test	$\chi^2_{(44)} = 30.57$	$\chi^2_{(44)} = 42.91$
Number of observations		149
Null: nonrural on rural $\sum \gamma_j = 0$		$\chi^2_{(1)} = 0.45$
Null: rural on nonrural $\sum \phi_j = 0$		$\chi^2_{(1)} = 4.69^{**}$

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Data from BLS payroll survey, 1990 to 2003.

\*The variable is significant at 90% confidence level.

\*\* The variable is significant at 95% confidence level.

\*\* \*The variable is significant at 99% confidence level.

**Table 3. Unit Root Results for Rural and Non-rural Job Growth, 1972 - 2003**

Variable	Levels
Rural growth	-3.49*
Non-rural growth	-2.84*

Data from BLS payroll survey, 1972-2003.

\*Significant at 10% critical value is -2.57

**Table 4: Results of the Likelihood Ratio Test for Lag Specification**

Model	Likelihood ratio statistic	Degrees of freedom	95% critical value	Test result
VARMA(p=5, q=12)				
against	3.74	4	9.48	accept
VARMA (p=5, q=12)				VARMA (p=5, q=12)
VARMA (p=6, q=12)				
VARMA(p=4, q=12)				
against	10.05	8	15.51	accept
VARMA (p=4, q=12)				VARMA (p=4, q=12)
VARMA (p=6, q=12)				
VARMA(p=3, q=12)				
against	39.54	12	21.02	reject
VARMA (p=3, q=12)				VARMA (p=3, q=12)
VARMA (p=6, q=12)				



**Table 5. Coefficient Estimates for VARMA(4,12) Rural and Non-rural Job Growth**

Variable	Non rural equation coefficients	Rural equation coefficients
constant	0.020	0.072
non rural (t-1)	1.185***	0.182***
non rural (t-4)	-0.211***	-0.188***
rural (t-1)	0.082***	0.999***
rural (t-4)	-0.066***	-0.034
Break	0.164**	-0.190
ma (t-12)	0.577***	0.772***
MSE	0.071	0.280
R-square	0.9836	0.930
Number of observations	354	
Granger causality test		
Null: non-rural on rural	likelihood ratio test statistic 38.59***	
$\gamma_1 = \gamma_4 = 0$		
Null: rural on non-rural	likelihood ratio test statistic 10.27***	
$\varphi_1 = \varphi_4 = 0$		

Data based on BLS payroll survey 1972 to 2003.

\*\* The variable is significant at 95% confidence level.

\*\*\* The variable is significant at 99% confidence level.

**Table 6. Recovery Periods**

Trough	Peak	Recovery
March 1975	January 1980	April 1975 - March 1977
July 1980	July 1981	August 1980 - July 1981
Nov 1982	July 1990	Dec 1982 - Nov 1984
March 1991	March 2001	April 1991 - March 1993
Nov 2001		Dec 2001 - Dec 2002

**Table 7. Coefficient estimates for modified system.**

Variable	Non-rural equation coefficients	Rural equation coefficients
constant	0.020	0.072
non-rural (t-1)	1.182***	0.182***
non-rural (t-4)	-0.208***	-0.188***
rural (t-1) during recovery	0.082***	
rural (t-4) during recovery	-0.063***	
rural (t-1) no recovery#	0.081***	0.999***
rural (t-4) no recovery#	-0.067***	-0.034
Break	0.161**	-0.190
ma (t-12)	0.581***	0.772***
MSE	0.071	0.279
R-square	0.984	0.930
Number of observations	354	

# In the rural employment growth equation, these variables are lagged rural employment growth.

\*\* The variable is significant at 95% confidence level.

\*\*\* The variable is significant at 99% confidence level.