



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Staff Paper No. 358

February 1996

**A Structural County-Level Model of Human Capital
Investment and Manufacturing Sector Change: 1980–90**

by

Stephan J. Goetz,
Dayuan Hu and David L. Debertin

Staff papers are published without formal review. Opinions expressed are the authors' and not necessarily those of the College of Agriculture, Agricultural Experiment Station, Cooperative Extension Service or the University of Kentucky.

A Structural County-Level Model of Human Capital Investment and Manufacturing Sector Change: 1980–90

by

Stephan J. Goetz

Dayuan Hu

and

David L. Debertin*

Department of Agricultural Economics

University of Kentucky

February 1996

*The authors are associate professor, post-doctoral researcher and professor, respectively. Please send correspondence to: Stephan J. Goetz, 317 Agricultural Engineering Building, University of Kentucky, Lexington, KY, 40546-0276; *e-mail*: AECGOETZ@UKCC.UKY.EDU

Prepared for presentation at the annual Atlantic Economic Conference, Paris, France, March 1996. Research underlying this manuscript was funded in part under the National Research Initiative, Competitive Grants Program of USDA/ERS (Grant no. 93-37401-9376); this agency is not responsible for the views expressed here.

A Structural County-Level Model of Human Capital Investment and Manufacturing Sector Change: 1980-90

Introduction

Manufacturing job losses have been widespread in many regions of the U.S. and Europe.¹ In the U.S., manufacturing employment has gradually shifted from the Midwest and Northeast manufacturing belt to the South, and from there to off-shore destinations, as firms sought low-wage locations. Similarly, many high-wage European countries have lost--and continue to lose--manufacturing jobs. Perhaps ironically, some of these jobs were re-located to the U.S., as illustrated recently by automakers BMW and Mercedes.

Manufacturing activity is a critical measure for many state and local public decision-makers, because it is seen as one of the few *bona fide* sources of economic wealth creation. The question arises, is it possible for state and county governments to reduce recent manufacturing losses by raising worker productivity through greater investment in formal education, or do increases in educational attainment lead to accelerated manufacturing job loss via higher labor productivity? Further, what is the effect of increased human capital accumulation in a county on manufacturing earnings as a measure of worker productivity, and are more rapid earnings increases associated with higher rates of investment in human capital?

The objective of this paper is to empirically examine the relationship between changes in per capita manufacturing employment, manufacturing earnings per worker and human capital investment in nearly 3,000 U.S. counties over the period 1980-90. Two key hypotheses are tested:

1. Communities in which residents invested more heavily in human capital (formal education) in the 1980s were in a better position to stem the erosion of manufacturing jobs, and experienced more rapid increases in manufacturing earnings per worker.
2. Communities in which manufacturing jobs and earnings per worker both increased invested more heavily in human capital, *ceteris paribus*.

These hypotheses address the questions of whether the sectoral composition of the local economy (in this case with an emphasis on manufacturing) affects per worker earnings growth and investment in human capital, and whether investment in human capital in turn affects the economy's sectoral

¹According to U.S. Commerce Department statistics, 20,776,600 workers were employed in manufacturing in 1980, compared with 19,755,600 workers in 1990.

composition and earnings growth. Therefore, this paper attempts to synthesize three separate and largely independent literatures, dealing with manufacturing job growth, earnings growth and human capital accumulation.

Model Specification

The structural model consists of three endogenous variables—(a) human capital accumulation, (b) change in manufacturing jobs per capita and (c) growth in manufacturing earnings per job. Since no consensus on a theoretical framework exists in the literature for specifying these equations, previous empirical studies are used to guide the equation specification.

Specification of the Manufacturing Employment Growth Equation

During the past few decades, the shift of manufacturing from the North to the South and the West has motivated numerous studies on the determinants of U.S. employment growth. Using state-level data from 1947 to 1963 and a step-wise correlation analysis, Wheat (1973) found that market access, climate, labor, level of economic development, resources, and urban status were key determinants of manufacturing employment growth.

Following Wheat, Plaut and Pluta (1983) regressed employment growth on different measures of economic conditions and climate, and identified a different set of significant explanatory variables. Wheat (1987) found a few changes in the ranking of important explanatory variables when he repeated his earlier study using 1963-77 data. For example, he found that urban attraction had turned to rural attraction. Newman (1983) used data at both industry and state levels to study industrial employment growth differentials between southern states and national averages. His regressors included changes in corporate tax rates and unionized worker shares between 1957 and 1973, as well as business climate (measured by right-to-work laws).

Unlike previous researchers, Carlino and Mills (1985, 1987) examined simultaneous growth in employment and population using county-level data, which provided a large cross-sectional sample. Educational attainment was found to have a negative (but insignificant) influence on manufacturing employment growth in the 1985 paper, while the effect of interstate highway access was positive. In addition, Carlino and Mills analyzed both direct and indirect effects of public policy variables using their simultaneous equations. A more recent study is by Crandall (1993), who used state-level data from 1967 to 1989. Starting with an initial employment equilibrium, he analyzed employment growth rates over time with regressors measured in the initial year.

Based on these previous studies of determinants of manufacturing employment growth, a linear equation with regressors measured at initial levels is specified. Change in manufacturing employment per capita between 1980 and 1990, ΔN , is:

$$\Delta N = a_{10} + a_{11}N_0 + a_{12}H_0 + a_{13}W_0 + \Gamma S_0 + u_1 \quad (1)$$

where N_0 , H_0 , and W_0 are manufacturing employment per capita, educational attainment, and manufacturing earnings per worker in 1980, respectively; S_0 is a set of regressors representing control variables and other relevant social-economic variables; $a_{10} \dots a_{13}$ and Γ are parameters to be estimated; and u_1 is a random disturbance.

S -variables were selected based on previous studies: metropolitan (*METR*) and rural (*RURL*) indicator variables control for urbanization effects;² interstate highway exits per county (*HIWY*) measure transportation infrastructure access for shipping goods; per capita highway spending (*HIXP*) is a proxy for local public-sector investment; land per capita (*LAND*) captures the potential to expand manufacturing facilities (Plaut and Pluta, 1983); a state-level corporate tax capacity index (*CTXC*) reflects whether manufacturers are deterred from locating in a state; and state-level unionization rates (*UNIN*) and an indicator variable for right-to-work laws (*RTWL*) measure business climate.

Specification of the Human Capital Growth Equation

Previous studies on human capital accumulation used output and initial educational attainment as regressors (e.g., Mankiw, Romer and Weil, 1992; Jones, 1995; Goetz and Ready, 1995; Goetz and Hu, 1996). We again assume a linear relationship exists among the variables, and include a vector of explanatory variables, denoted by T . Change in educational attainment, ΔH , is:

$$\Delta H = a_{20} + a_{21}N_0 + a_{22}H_0 + a_{23}W_0 + \Theta T_0 + u_2 \quad (2)$$

where a_{20}, \dots, a_{23} and Θ are parameters to be estimated, and u_2 is a random disturbance.

Our choice of T -variables is again based on previous studies, most of which are based on surveys of individuals. Variables such as gender, number of siblings, educational attainment of parents, income, region of residence in the U.S. (Cameron and Heckman, 1993); household head age

¹Based on the USDA's Beale code; the excluded category consists of counties having one or more places with at least 2,500 residents but which are not considered to be metropolitan areas.

and occupation and home ownership (Hauser, 1993); and unemployment rates, wages and city population (Cohn and Hughes, 1994) have all been found to influence college attendance.³

In addition to *METR* and *RURL* (which measure impacts of city size), we include as regressors the rate of unemployment (*UNEM*); per capita taxes raised locally (*TAXL*, for which a negative sign is expected according to Nerlove *et al.*, 1993); average size of family (*FAMS*); home ownership status (*HOWN*); and the share of professional employment in the local work (*PROF*). Katz (1992) argues that so-called "neighborhood effects" influence an individual's economic decisions. We hypothesize that children living in communities with a high proportion of employment in the professions are more likely to invest in higher education, as they observe positive net returns to education earned by professionals. In addition, workers in professional occupations are more likely to persuade their own children to invest heavily in formal schooling.

Specification of the Earning Equation

Slichter's 1950 study of determinants of earnings (or wage) growth used plant-level data. He found that unskilled male workers' earnings were positively correlated with skilled workers' wages, value added per worker, the value product of labor and firms' profits as a proportion of sales, but negatively related to the share of female employment. Using industry-level data, Brown (1962) found wages were positively correlated with firm concentration ratios and employment per firm. Earlier research also suggests that firm size positively affect earnings, due to principal-agent problems (e.g., Kraybill, Yoder and McNamara, 1991). In explaining regional wage differentials in the U.S., Scully (1969) found that human capital had a statistically significant positive effect on wages. Initial levels of earnings were reported to have a depressing effect on subsequent earnings growth by De Menil (1971) and Tylecote (1975).

Additional explanatory variables were introduced into empirical analyses of wage determinants since the 1980s. Pugel's (1980) cross-sectional regression revealed significant positive effects of skills and the share of workers of prime working age on hourly earnings, and negative influences of shares of workers that are from a minority group, unionized, and located in the South. More recently, Hyclak and Johns (1992) reported that right-to-work laws positively affected wage flexibility, and hence negatively affect earnings. In addition, Coelho and Ghali (1971), Bellante (1979) and Roback

³These studies use data from the National Longitudinal Survey of Youth; Current Population Survey; and Panel Study of Income Dynamics, respectively.

(1988) showed that costs of living are important determinants of inter-regional wage differentials. Carruth and Oswald's (1989) empirical results for Britain also show a significant positive relationship between housing prices and wages.

Based on these previous studies, we define a linear function of growth in manufacturing earnings per worker, ΔW , as:

$$\Delta W = a_{30} + a_{31}N_0 + a_{32}H_0 + a_{33}W_0 + \Psi Z_0 + u_3 \quad (3)$$

where a_{30} , ..., a_{31} and Ψ are parameters to be estimated, and u_3 is a random disturbance. Based on the review above, Z -variables include median age (*MAGE*), employment per firm (*EPFM*), populations shares of African-americans (*AAPO*) and Hispanic origin (*HSPO*), and housing costs (*HCST*).⁴

Manufacturing data represent full- and part-time jobs and earnings, and are from the Regional Economic Information System of the U.S. Dept. of Commerce. The other county-level regressors are from the U.S. County CD ROM disk issued by the Department of Commerce (U.S. Census data), or from the USDA (for the Beale code). Due to disclosure rules it was not possible to include all U.S. counties in the analysis (a problem also encountered by Carlino and Mills).

Discussion of Results

OLS Regressions

Equations (1), (2) and (3) are initially estimated using OLS (Table 1). Statistically significant relationships between the endogenous (growth) variables and their initial levels are shown in Figure 1. As expected, counties with higher initial levels of educational attainment had greater increases in earnings per worker during the past decade. Also, counties with higher per worker earnings had lower manufacturing employment growth rates. Convergence across counties is observed both in educational attainment and in per capita manufacturing employment, but *not* in earnings, and initial manufacturing employment per capita had a positive effect on educational attainment and per worker earnings growth. However, as was true in Carlino and Mills (1985), the coefficient estimate for initial educational attainments is negative in the equation for manufacturing employment growth. This

⁴These are calculated as an "average of median selected monthly owner costs of specified owner-occupied non-condominium housing units with a mortgage" and "median gross rent of specified renter-occupied housing units paying cash rent" (*source*: as defined by U.S. Dept. of Commerce, on USA County CD ROM Disk, 1994).

suggests that greater investment in skills was unable to stem the erosion of manufacturing jobs between 1980 and 1990. This issue is analyzed in more detail below.

Most of the statistically significant exogenous variables have expected signs. However, in contrast with many previous studies, Table 1 reveals a positive effect of *UNN* in the manufacturing employment equation and positive effects of *AAPO* in the earnings-per-worker equation. Contradictory effects of unionization on industrial productivity are discussed in Moomaw and Williams (1991).⁵

Simultaneous Specification and 3SLS Regression Results

Previous research on determinants of economic growth has largely been based on OLS estimates of equations such as (1), (2) or (3) above. More specifically, effects of initial levels of variables on the growth in manufacturing employment, educational attainment and earnings per worker have usually been studied independently. However, simultaneous equation bias is a potentially serious problem in these specifications, as noted recently by Mankiw (1995) and Goetz and Hu (1996). To illustrate, initial levels of both educational attainment and per worker earnings in equation (1) are treated as exogenous. However, more rapid increases in educational attainment may have been a function of earnings growth over the period studied, and vice versa.

Over a short time period (e.g., one year), the influences of endogenous variables may be negligible. Over a longer period, such as a decade, their influence can be considerable. For example, Katz's "neighborhood effect" is likely to be even stronger in a dynamic (as opposed to static) setting. This leads to the following simultaneous equation specification:

$$\Delta N = a_{10} + a_{11}N_0 + a_{12}H_0 + a_{13}W_0 + \Gamma S_0 + b_{12}\Delta H + b_{13}\Delta W + u_1 \quad (4)$$

$$\Delta H = a_{20} + a_{21}N_0 + a_{22}H_0 + a_{23}W_0 + \Theta T_0 + b_{21}\Delta N + b_{23}\Delta W + u_2 \quad (5)$$

$$\Delta W = a_{30} + a_{31}N_0 + a_{32}H_0 + a_{33}W_0 + \Psi Z_0 + b_{31}\Delta N + b_{32}\Delta H + u_3 \quad (6)$$

This system is estimated simultaneously using 3SLS (Table 2). Statistically significant relationships among endogenous variables and their initial levels are shown in Figure 2.

⁵In particular, Moomaw and Williams (p. 25) suggest that "entrenched unions decrease TFP [total factor productivity] growth through various types of work rules and featherbedding, but that increasing levels of unionization increase TFP growth because of improvement in morale and increased labor voice".

Differences in Effects of Initial Levels: Simultaneous vs. Reduced-Form Estimation

Compared with Figure 1, there are three important differences between the original (OLS) and simultaneous (3SLS) specifications. First, as hypothesized, the effect of initial educational attainment on growth in manufacturing employment is positive when simultaneity is imposed. This is in contrast to the negative coefficient estimate obtained using OLS. Second, convergence is observed in the 3SLS formulation for per worker earnings, but not for manufacturing employment. Third, the statistically significant effect of initial manufacturing employment on each of the three growth variables in the OLS model disappears in the 3SLS regressions.

To explain these differences, we first analyze the reduced-form estimators of the simultaneous system, and then compare them with the 3SLS structural-form estimators. Denote:

$$B = \begin{bmatrix} 1 & -b_{12} & -b_{13} \\ -b_{21} & 1 & -b_{23} \\ -b_{31} & -b_{32} & 1 \end{bmatrix}, \quad \Delta Y = \begin{bmatrix} \Delta N \\ \Delta H \\ \Delta W \end{bmatrix}$$
$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}, \quad Y_0 = \begin{bmatrix} N_0 \\ H_0 \\ W_0 \end{bmatrix}, \quad R = \begin{bmatrix} a_{10} + \Gamma S + u_1 \\ a_{20} + \Theta T + u_2 \\ a_{30} + \Psi Z + u_3 \end{bmatrix}$$

Equations (4), (5) and (6) can be rewritten as:

$$B\Delta Y = AY_0 + R \tag{7}$$

The reduced-form of this system is:

$$\Delta Y = B^{-1}A Y_0 + B^{-1}R \tag{8}$$

and the reduced-form coefficient matrix of the initial endogenous variables is:

$$\Pi = B^{-1}A = \frac{1}{|B|} \begin{bmatrix} 1 - b_{23}b_{32} & b_{12} + b_{13}b_{32} & b_{13} + b_{12}b_{23} \\ b_{21} + b_{23}b_{31} & 1 - b_{13}b_{31} & b_{23} + b_{21}b_{13} \\ b_{31} + b_{21}b_{32} & b_{32} + b_{31}b_{12} & 1 - b_{12}b_{21} \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \quad (9)$$

$$= \begin{bmatrix} \pi_{11} & \pi_{12} & \pi_{13} \\ \pi_{21} & \pi_{22} & \pi_{23} \\ \pi_{31} & \pi_{32} & \pi_{33} \end{bmatrix}$$

where

$$|B| = 1 - b_{12}b_{23}b_{31} - b_{13}b_{32}b_{21} - b_{12}b_{21} - b_{13}b_{31} - b_{23}b_{32} \quad (10)$$

The effect of initial levels of educational attainment on manufacturing employment growth can be analyzed using the reduced-form parameter:

$$\pi_{12} = \frac{1}{|B|} [(1 - b_{23}b_{32}) a_{12} + (b_{21} + b_{13}b_{32}) a_{22} + (b_{13} + b_{12}b_{23}) a_{32}] \quad (11)$$

This parameter includes the direct initial effect, represented by a_{12} , and three indirect effects: the interaction between ΔH and ΔW , the influence of H_0 on ΔN through ΔH , and the influence of H_0 on ΔN through ΔW . In this particular case, the first effect is small, but the second and third indirect effects are large and in the opposite direction, thereby offsetting the initial effect. The direct positive effect of initial educational attainment on manufacturing employment is dominated by the negative indirect effects. As a result, with the reduced-form estimator we observe a negative comprehensive effect which likely differs from the true direct effect of initial educational attainment on manufacturing employment growth.

A similar analysis can be used to explain differences in the impact of the initial level of a variable on its subsequent change in the OLS as opposed to the 3SLS model. Convergence of per worker earnings is measured by the coefficient on initial per worker earnings. The corresponding parameter in the reduced form is:

$$\pi_{33} = \frac{1}{|B|} [(b_{31} + b_{21}b_{32}) a_{13} + (b_{32} + b_{31}b_{12}) a_{23} + (1 - b_{12}b_{21}) a_{33}] \quad (12)$$

The first and second terms in the []-brackets represent the indirect effects of W_0 on ΔW through ΔN ,

and of W_0 on ΔW through ΔH . The third term captures the direct initial effect represented by a_{33} , and the interaction between ΔN and ΔH . Using the estimators of this particular problem, our calculations show that the effects of the second term and the interaction between ΔN and ΔH are negligible. The effect of W_0 on ΔW through ΔN has almost the same magnitude as, but is in the opposite direction of a_{33} . Consequently, the effect of convergence of per worker earnings is offset by the indirect effects, and the estimator obtained in the reduced-form is not statistically significant.

The third difference in the OLS and 3SLS results involves the determinant, $|B|$, which indicates the strength of interaction between growth variables in the system. So long as $|B| \geq 0$, signs of the reduced-form estimators are not changed. However, $|B|$ affects the statistical significance of the coefficient estimates. This can be shown using π_{11} as an example:

$$\pi_{11} = \frac{1}{|B|} [(1 - b_{23}b_{32}) a_{11} + (b_{21} + b_{13}b_{32}) a_{21} + (b_{13} + b_{12}b_{23}) a_{31}] \quad (13)$$

The estimate of a_{11} is not statistically significant. But, as a result of the reduced-form estimation, the effect indicated by a_{11} is magnified when the first term in the brackets is multiplied by $1/|B|$. The smaller $|B|$, the greater this magnified effect. Here, $|B| = 0.3003$, and hence, $1/|B| = 3.33$. Note that a_{11} shows a considerable effect of initial manufacturing employment on its subsequent growth, even though it is not statistically insignificant at the 0.10 level with a t -statistic of 1.53. In the reduced-form estimation, the magnified effect of a_{11} affects not only the estimated effect of N_0 on ΔN , but also that of N_0 on ΔH and of N_0 on ΔW .

Table 3 includes 3SLS reduced-form estimates of parameters of each endogenous variable at initial levels in each equation. Comparing these results with the OLS regression results in Table 1, it is evident that the statistically significant OLS estimates of the initial endogenous variables have the same sign as the corresponding 3SLS reduced-form coefficient estimate.

Concluding Remarks and Policy Implications

The results in Tables 1 and 2 lead to different policy recommendations for county-level decision-makers seeking to stem the erosion of manufacturing jobs or attempting to re-industrialize their economies. According to Figure 1, counties starting out with higher stocks of human capital in 1980 lost more (or gained fewer) manufacturing jobs in the subsequent decade than did counties starting out with lower stocks, *ceteris paribus*. Thus, higher levels of formal skills in the county did not prevent a loss of manufacturing jobs. Figure 2 provides more detail about the direct and indirect

effects involved in this process. More specifically, Figure 2 shows that if simultaneous changes in earnings and human capital stocks during the 1980s are accounted for, higher initial stocks of human capital were, in fact, *positively* associated with employment growth. However, this positive effect was more than offset by two counteracting forces: (1) counties with higher initial human capital stocks invested less in additional education, which, in turn, depressed job growth; (2) counties with higher initial human capital stocks experienced more rapid per manufacturing worker earnings growth, which also served to stem job growth. Thus, the overall effect of higher human capital stocks on manufacturing job growth was negative. It is noteworthy that higher *rates* of growth in human capital were associated with higher rates of manufacturing employment growth, *ceteris paribus*. It is not possible to detect these subtle effects from Figure 1 or a single-equation analysis.

Another remarkable conclusion is that convergence of manufacturing employment per capita across counties between 1980 and 1990 disappears once one allows for simultaneity between the endogenous variable. In Figure 2, initial levels of manufacturing employment per capita no longer have an effect on employment growth, or on either of the two other growth variables. Conversely, according to Figure 1, manufacturing earnings did not converge during the 1980s, suggesting that manufacturers, on balance, failed to move jobs between counties to equalize workers' marginal value products (assumed to be reflected in earnings per worker). However, Figure 2 reveals that earnings per worker converged, as measured by the direct effects, after controlling for the other endogenous variables. At the same time, counties with higher initial earnings experienced less rapid employment growth (or more rapid losses), suggesting that manufacturers continued to shift employment out of high-wage counties, in turn attenuating inflationary pressures on earnings.

During the 1980s, traditional fiscal policies (such as state-wide corporate income taxes and county-level taxes on individuals), had statistically significant depressing effects on manufacturing employment growth and investment in human capital, respectively. In addition, county-level decision-makers face the following trade-offs in terms of moving their economies into the information age. In terms of direct effects, counties already endowed with high human capital stocks experienced faster growth in manufacturing employment, less additional human capital accumulation, and faster increases in manufacturing earnings per job, all else equal. Counties with greater increases in human capital stocks experienced faster employment and earnings growth, but this growth was depressed by faster earnings inflation. The *net* effect of these forces was to depress employment growth in counties starting out with higher initial stocks of human capital. Also, faster earnings growth did not lead to faster rates of human capital accumulation.

References

- Barro, R. J., "Economic Growth in a Cross Section of Countries," *Quarterly Journal of Economics*, 106(2), pp. 407-443, 1991.
- Barro, R. J., "Human Capital and Economic Growth," in *Policies for Long-Run Economic Growth*, a symposium sponsored by The Federal Reserve Bank of Kansas City, 1992.
- Barro, R. J., and X. Sala-I-Martin, *Economic Growth*, New York: McGraw-Hill, 1995.
- Bellante, D. "The North-South Differential and the Migration of Heterogeneous Labor," *American Economic Review*, 69(1):166-175, 1979.
- Brown, D.G. "Expected Ability to Pay and Inter-Industry Wage Structure in Manufacturing", *Industrial and Labor Relations Review*, 16: 45-62, 1962.
- Cameron, S.V. and J.J. Heckman, "Comment on Trends in College Entry among Whites, Blacks and Hispanics," in C.T. Clotfelter and M.Rothschild, eds., *Studies of Supply and Demand in Higher Education*, The University of Chicago Press, 1993.
- Carlino, G.A., and E.S. Mills, "The Determinants of County Growth," *Journal of Regional Science*, 27(1), pp. 39-54, 1987.
- Carlino, G.A., and E.S. Mills, "Do Public Policies Affect County Growth?" *Business Review*, Federal Reserve Bank of Philadelphia, July/August 1985, pp. 3-16.
- Coelho, P.R. and M.A. Ghali, "The End of the North-South Wage Differential," *American Economic Review*, 61(5):932-937, 1971.
- Cohn, E. and W.W. Hughes, Jr, "A Benefit-Cost Analysis of Investment in College Education in the United States: 1969-1985," *Economics of Education Review*, 13(2) pp. 109-123, 1994.
- De Menil, G. *Bargaining: Monopoly Power Versus Union Power*, Cambridge, MA: MIT Press, 1971.
- Goetz, S.J. and D. Hu, "Economic Growth and Human Capital Accumulation: Simultaneity and Expanded Convergence Tests," Dept. of Agric. Econ., Univ. of Kentucky, Staff Paper No. 355, January 1996, 10pp.
- Goetz, S.J. and R.C. Ready, "Modeling Economic Growth with Unpredictable Shocks: A State-Level Application for 1960-90," *Journal of Agricultural and Applied Economics*, 27(2)1995:400-8.
- Hauser, R.M., "Trends in College Entry among Whites, Blacks and Hispanics," in C.T. Clotfelter and M.Rothschild, eds., *Studies of Supply and Demand in Higher Education*, The University of Chicago Press, 1993.
- Hyclak, T. and G. Johns, *Wage Flexibility and Unemployment Dynamics in regional Labor Market*, W.E. Upjohn Institute for Employment Research, MI, 1992.
- Jones, C.I., "Time Series Tests of Endogenous Growth Model," *Quarterly Journal of Economics*, 110(2), pp. 495-525, 1995.
- Katz, L., "Recent Development in Labor Economics," American Economic Association lecture series on Recent Development in Economics; presented at the annual American Economic Association meetings, New Orleans, LA 1992.
- Kraybill, D., M.J. Yoder and K.T. McNamara, "Employer Size, Human Capital and Rural Wages: Implications for Southern Rural Development," *Southern Journal of Agricultural Economics*, 23(2)1991:85-94.
- Lee, D.W., and T.H. Lee, "Human Capital and Economic Growth: Tests Based on the International Evaluation of Educational Achievement," *Economics Letters*, 47, pp. 219-225, 1995.
- Mankiw, N.G., "The Growth of Nations," *Brookings Papers on Economic Activity*, 1:1995, pp. 275-310, 1995.
- Mankiw, N.C., D. Romer, and D.A. Weil, "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics*, 107(2), pp. 407-437, 1992.

- Moomaw, R.L., and M. Williams, "Total Factor Productivity Growth in Manufacturing: Further Evidence from the States," *Journal of Regional Science*, 31(1), pp. 17-34, 1991.
- Nerlove, M., A. Razin, E. Sadka, R.K. von Weizsäcker, "Comprehensive Income Taxation, Investments in Human and Physical Capital, and Production," *Journal of Public Economics*, 50, pp. 397-406, 1993.
- Newman, R.J. "Industry Migration and Growth in the South," *Review of Economics and Statistics*, 65(1), pp.76-86, 1983.
- Plaut, T.R., and J.E. Pluta, "Business Climate, Taxes and Expenditure, and State Industrial Growth in the United States," *Southern Economic Journal*, 51(1), pp. 99-119, 1983.
- Pugel, T.A. "Profitability, Concentration, and the Interindustry Variation in Wages," *Review of Economics and Statistics*, 62: 248-253, 1980.
- Roback, J. "Wages, Rents, and Amenities: Differences among Workers and Regions," *Economic Inquiry*, 26:23-41, 1988.
- Scully, G. "Interstate Wage Differentials: A Cross Section Analysis," *American Economic Review*, 59(5):757-773, 1969.
- Slichter, S.H. "Notes on the Structure of Wage Rates," *Review of Economics and Statistics*, 32: 80-91, 1950.
- Tylecote, A.B. "Determinants of Changes in the Wage Hierarchy in UK manufacturing industry: A Test of a New Theory of Wage Determination Under Collective Bargaining," *British Journal of Industrial Relations*, 13:65-77, 1975.
- Wheat, L.F., *Regional Growth and Industrial Location*, Lexington Boos, D.C. Heath and Company, 1973.
- Wheat, L.F., "The Determinants of 1963-77 Regional Manufacturing Growth: Why the South and West Grow," *Journal of Regional Science*, 26(4), pp. 635-659, 1986.

Table 1. OLS regression results with single equation specification

Variable	Manufacturing employment		Educational attainment		Earnings per worker		Summary Statistics	
	ΔN		ΔH		ΔW		Mean	Std. Dev.
Constant	0.0233***	(5.68)	0.224***	(21.10)	-3.295***	(2.66)		
N_0 (persons/cap.)	-0.0729***	(7.06)	0.037***	(3.51)	6.772***	(2.82)	0.072	0.054
H_0 (percent)	-0.0156***	(3.08)	-0.208***	(34.64)	3.004***	(2.66)	0.593	0.124
W_0 (\$'000/worker)	-0.000907***	(7.22)	-0.000066	(0.50)	0.0115	(0.49)	15.228	5.149
$METR$ (0,1)	-0.00399***	(3.07)	0.0145***	(10.62)	1.970***	(8.12)	0.235	0.424
$RURL$ (0,1)	-0.00303**	(2.30)	0.00171	(1.22)	0.890***	(3.82)	0.212	0.409
$HIWY$ (0,1)	-0.00191**	(1.99)					0.431	0.495
$HIXP$ (\$'000/cap.)	0.0478***	(3.61)					0.056	0.042
$LAND$ (acres/cap.)	-0.00267	(1.53)					0.070	0.280
$CTXC$ (index)	-0.00501***	(4.13)					0.908	0.436
$UNIN$ (proportion)	0.0446***	(4.75)			-2.267	(1.33)	0.214	0.080
$RTWL$ (0,1)	0.00275*	(1.82)			-1.609***	(6.16)	0.509	0.500
$UNEM$ (proportion)			-0.179***	(10.72)			0.069	0.032
$TAXL$ (\$'000/cap.)			-0.0176***	(3.63)			0.223	0.143
$FAMS$ (persons)			-0.0188***	(7.25)			2.800	0.216
$HOWN$ (proportion)			0.0819***	(10.02)			0.733	0.076
$PROF$ (proportion)			0.171***	(4.35)			0.035	0.015
$MAGE$ (years)					0.126***	(4.87)	30.951	3.764
$EPFM$ (persons/firm)					0.016***	(5.59)	59.773	45.200
$AAPO$ (proportion)					6.936***	(9.08)	0.090	0.146
$HSPO$ (proportion)					5.283***	(5.29)	0.034	0.093
$HCST$ (\$/month)					0.020***	(7.23)	250.864	53.134
ΔN							0.0014	0.0268
ΔH							0.1033	0.0380
ΔW							9.1533	5.0515
Adjusted R^2	0.1033		0.4822		0.1828			

Notes: Absolute value of t -statistics in parentheses. Significance levels: *=10%, **=5%, ***=1% or lower. Sample size=2,880. All regressors are measured in 1980 where possible, or in the closest census year (i.e., 1982). ΔN , ΔH and ΔW measure the between the 1990 and 1980 value of each variable.

Table 2. 3SLS regression results with simultaneous equations specification

Variable	Manufacturing employment ΔN		Educational attainment ΔH		Earnings per worker ΔW	
Constant	0.00875	(0.81)	0.203***	(19.80)	0.169	(0.08)
N_0 (persons/cap.)	-0.0220	(1.53)	0.00582	(0.47)	-1.864	(0.76)
H_0 (percent)	0.0300***	(2.76)	-0.214***	(29.94)	5.770**	(2.45)
W_0 (\$'000/worker)	-0.000625***	(4.17)	-0.000176	(1.01)	-0.117***	(3.90)
<i>METR</i> (0,1)	0.00381*	(1.89)	0.00755***	(4.28)	1.143***	(3.73)
<i>RURL</i> (0,1)	-0.000014	(0.01)	0.000118	(0.08)	0.298	(1.06)
<i>HIWY</i> (0,1)	-0.000042	(0.09)				
<i>HIXP</i> (\$'000/cap.)	0.00588	(0.77)				
<i>LAND</i> (acres/cap.)	-0.00208	(1.48)				
<i>CTAC</i> (index)	-0.00228**	(2.56)				
<i>UNIN</i> (proportion)	0.0333***	(3.06)			5.857***	(2.76)
<i>RTWL</i> (0,1)	-0.000114	(0.06)			-0.230	(0.73)
<i>UNEM</i> (proportion)			-0.175***	(9.83)		
<i>TAXL</i> (\$'000/cap.)			-0.0212***	(4.23)		
<i>FAMS</i> (persons)			-0.0194***	(7.24)		
<i>HOWN</i> (proportion)			0.091***	(10.62)		
<i>PROF</i> (proportion)			0.166***	(4.31)		
<i>MAGE</i> (years)					0.0245	(1.12)
<i>EPFM</i> (persons/firm)					0.00407**	(1.96)
<i>AAPO</i> (proportion)					2.631***	(3.81)
<i>HSPO</i> (proportion)					-0.837	(1.05)
<i>HCST</i> (\$/month)					0.0102***	(4.45)
ΔN			0.111	(0.77)	-187.013***	(13.36)
ΔH	0.136***	(2.85)			24.334**	(2.36)
ΔW	-0.00373***	(7.78)	0.00272***	(4.85)		
System-weighted R^2			0.3033			

Notes: Absolute value of *t*-statistics in parentheses. Significance levels: *=10%, **=5%, ***=1% or lower. Sample size=2,880

Table 3. 3SLS reduced-form estimates

	ΔN	ΔH	ΔW
N_0	-0.04674	0.02070	7.3812
H_0	-0.003211	-0.2109	1.2387
W_0	-0.0006566	-0.0002515	-0.0007908

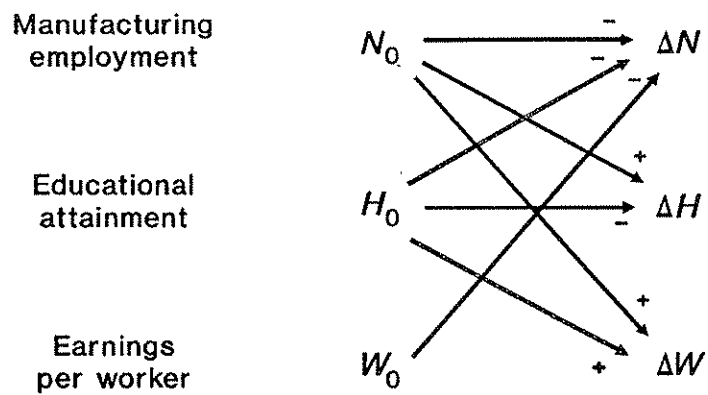


Figure 1. OLS Results for Single Equation Specification
(comprehensive effects)

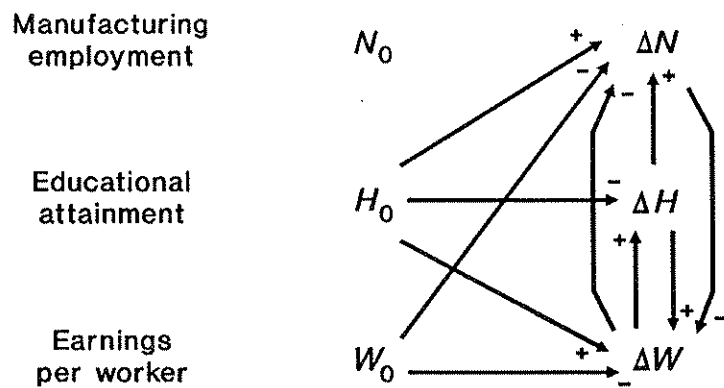


Figure 2. 3SLS Results for Simultaneous Equation Specification
(direct and indirect effects)