New Economy Indicators for Long-Term Industry Employment Projections

Report prepared for the
Projections Workgroup
Employment and Training Administration
U.S. Department of Labor

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May 2005

The author gratefully acknowledges the invaluable research assistance of Henry Renski, doctoral candidate in the Department of City and Regional Planning, University of North Carolina at Chapel Hill, and the helpful comments from Anthony Hayden, Larry Less, Bob Murdock, Alex Roubinchtein, Leora Starr, and Karin Wells on an earlier draft.

Final Report

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I. Introduction

The structure and performance of the national, state, and substate economies has changed considerably over the last 20 years. Despite the “dot com” bust of a few years ago, the globalization of production systems and of markets has altered the way firms do business, including their decisions on where to locate, where to expand or contract, and from where to purchase their inputs. The comparative advantages of many regions of the “old economy” – based upon low labor costs and large, vertically-integrated production – are frequently comparative disadvantages in the new economy. The most critical factors for a region’s economic sustainability are no longer access to raw materials and cheap, low-skilled labor. For state and substate economies to compete successfully 2003 and beyond will depend upon access to a highly skilled and highly educated work force, and a regional capacity and infrastructure for innovation and adaptiveness. In short, the rules have changed. The factors that can predict a region’s relative growth of employment in particular industries, relative to the nation, are likely to be quite different in the next ten years than than those traditionally used by regional and labor economists.

The specific objectives of this study have been: (1) to identify indicators available at the state level that are candidates for states to consider for helping to project future industry employment levels; (2) test how well the subset of the indicators that are deemed most fruitful improve projections for a sample of SICs; and (3) make a set of recommendations for states on projection models and model specifications, based upon the findings in (1) and (2). This report is organized in three additional sections that align with these objectives. In the next section we identify indicators that take into account new dimensions of state economic performance and sustainability and that also may be feasibly included in industry employment projection models. The third section reports on testing of how well these indicators help to accurately project industry employment over the recent historical period. The last section provides recommendations to LMI staff for improving their employment projections based upon the results of this study.

II. Indicators of the New Economy

While many factors of the old economy are still important, the globalization of production and the extent of the rate of technologiccal change, particularly in IT, have placed new requirements on regions’ ability to remain competitive and sustain and grow jobs and income. A study conducted by the Progressive Policy Institute, *The Metropolitan New Economy Index, Benchmarking Economic Transformation in the*

Nation's Metropolitan Areas, considers and compares the concepts and benchmarks between the "old economy" and the "new economy." These are distilled in Table 1.

In the old economy, comparative advantage was based upon lower production costs, economies of scale and mass production, and stable markets. In the new economy, quality of product, innovation, customization, and time-to-market supplant low production costs; flexible production, networks, and collaborative arrangements replace mass production and vertical integration; and stability recedes in favor of dynamism. When we focus these differences on jobs and employment, it is apparent that in the new economy it will be those regions with a rich and diverse supply of knowledge workers, with broad skills and cross-training, that will have critical advantages for maintaining or gaining shares of economic activity, income, and wealth.

Table 1

Characteristics of the Old and New Economy

Issue	Old Economy	New Economy
Economy-Wide Characteristics		
Markets	Stable	Dynamic
Organizational form	Hierarchical, bureaucratic	Networked, entrepreneurial
Scope of competition	National	Global
Geog mobility of business	Low	High
Competition between Regions	Low	High
Industry Structure		
Organization of product	Mass production	Flexible production
Key factors of production	Capital, labor	Knowledge, innovation
Key technology driver	Mechanization	Digitization
Source of competitive advantage	Lower cost thru economies of scale	Innovation, quality, time-to-market
Relations with other firms	Go it alone	Alliances, collaborations, networks
Workforce		
Principal policy goal	Full employment	Higher earnings
Skills	Job-specific	Broad skills, cross-training
Requisite education	A skill	Lifelong learning
Labor-management relations	Adversarial	Collaborative
Tenure of employment	Stable	Marked by risk and opportunity
Government		
Business/government relations	Regulatory	Provide assistance for innovation
Regulation	Command and control	Market-based incnetives, flexibility

Adapted from PPI, April 2001

The distinguishing characteristics of the new economy in Table 1 provide a useful starting point for identifying a set of candidate "indicators" of regional competitive advantage. To construct this list we concurrently scanned through the rather large amount of the “new economy” literature and held several “brainstorming” sessions. At this stage we sought to be as inclusive as possible. We then systematically investigated the *availability* of data for each of the indicators, looking at federal government, state government, and private data sources. This resulted in a list of over 100 potential indicators.

We next took a “harder” look at all of the indicators, with the aim of eliminating those that: (1) were not available at the state level in annual time-series since at least 1990; or (2) that we strongly suspected, a priori, would not be a good predictor of industry employment change in either a time-series regression model or in share or shift-share models. The results of this vetting process are shown in Table 2.

Table 2
Selected New Economy Variables

VARIABLE	DATA SOURCE
Investment in R&D	
Total industrial R&D	NSF-IRIS
Total industrial R&D as share of nation	NSF-IRIS
Total industrial R&D as share of Gross State Product	NSF-IRIS
Total SBIR funding	SBA-SBIR/STTR
Total SBIR funding as share of nation	SBA-SBIR/STTR
Total SBIR funding as share of GSP	SBA-SBIR/STTR
Total university R&D	NSF, WebCaspar
Total university R&D as share of nation	NSF, WebCaspar
Total university R&D as share of GSP	NSF, WebCaspar
Univ R&D, Science, Engineering, and Health (SEH)	NSF, WebCaspar
Univ R&D, SEH, as share of nation	NSF, WebCaspar
Univ R&D, SHE, as share of GSP	NSF, WebCaspar
Educational Infrastructure	
Graduate students, SEH	NSF- NIH Survey
Graduate students, SHE, as share of nation	NSF-NIH Survey
Graduate students, SEH as percent of population	NSF-NIH Survey
Doctoral recipients, SEH	NORC
Doctoral recipients, SEH, as share of nation	NORC
Doctoral recipients, SEH, as percent of population	NORC
Bachelor degrees awarded, SEH	NCES-IPEDS
Bachelor degrees awarded, SEH, as share of nation	NCES-IPEDS
Bachelor degrees awarded, science, engr, health, as percent of population	NCES-IPEDS
Public schools, average pupil to teacher ratio	NCES-CCD
Public schools, average teacher salary	NCES-CCD
Public schools, expenditures per student	NCES-CCD
Percent population with HS diploma	CPS (March)
Percent population with bachelor’s degree	CPS (March)

Innovativeness and Entrepreneurialism

Patents granted	USPTO-NBER
Patents granted as share of nation	USPTO-NBER
Patents granted per size of labor force	USPTO-NBER, BLS
Firm births	SBA
Firm births as share of nation	SBA
Firm births minus terminations	SBA

Productivity

Average earnings per job	BEA-REIS
Average earnings per job as percent of nation	BEA-REIS
Mfg value added as percent of value of shipments	BEA-ASM
Mfg value added per mfg employment	BEA-ASM

Each of the four categories of variables shown in Table 2 represents a dimension of a region's future *capacity* for economic and/or employment growth. Investment in R&D should lead to greater productivity and hence enhanced competitiveness. This holds not just for the so-called high tech industries but also for traditional industries, such as textiles, apparel, and furniture, all undergoing modernization. We would expect that variables measuring R&D investment would correlate most highly with industry employment when temporally lagged. We include both the absolute amount of R&D investment and a "share" formulation of the variable as alternative variable specifications. We also include the level of R&D investment standardized for the saize of the state's economy (gross state product) as an additional variable possibility.

The relative quality of a state's educational infrastructure will have an impact on the level of skill of the state's workforce, and more importantly, the future flow of human capital into the workforce. A region that has both a deep and broad *stock* of highly skilled workers and an educational system that will provide a reliable *flow* of highly skilled workers will have competitive advantages for attracting, growing, and sustaining innovative businesses. The number of degree recipients at various levels and in particular fields represent output measures of a state's system of higher education (public and private). Good measures of the quality of output from the K-12 educational system are more difficult to obtain. Instead we have chosen input measures expected to be correlated with the quality of output, such as as average teacher salaries, average class size, and average expenditures per pupil. Similarly to R&D investment, we include absolute levels, and state share of the nation as alternative varaible specifications. We also expect to there would be a "lagged" relationship between measures of educational quality and industry employment change.

Regions with high levels of entrepreneurialism and high concentrations of innovative firms will be those most able to adapt to changing and uncertain conditions, to reinvent and restructure their economies, and potentially to generate "gazelle" companies with the highest levels of job growth. Entrepreneurship and innovative activity are closely related. The factors that account for entrepreneurial activity and innovative activity include certain personal characteristics, such as risk-taking and creativity, but also include similar regional attributes that attract those individuals who are most likely to become entrepreneurs and innovators, e.g., the presence of role models, a tradition of risk-taking, availability of sources of venture capital, and a business culture and a set of business networks that support new business start-up and risk taking. The best measure of level of innovative activity is number of patents granted, although we recognize that not all innovations lead to patents (e.g., software). A region's level of entrepreneurial activity can be measured by the number of new firms, number of net new firms, or the state's share of new firms in the nation.

The variables under the category of productivity directly or indirectly measure the region's overall concentration in high or low value-added sectors. On the basis that the comparative advantage of the U.S. in the future will be in high value-added sectors, those regions with an already high concentration of value-added sectors will be more able to build upon this endowment, while regions with a low concentration of value-added sectors will be at a disadvantage. Specific variables here are average earnings per worker (all industries), value-added per worker (manufacturing), and value added as percent of value of shipments. Similarly to the other categories of variables, we allow for a lagged relationship between these variables and state industry employment.

III. The Design of the Tests

To ascertain the likelihood of whether a particular variable would potentially improve the accuracy of state industry employment projections, we have run multiple regression models that include (serially) the indicators described above as predictor variables, for a selected set of industry sectors in three states. The states are Ohio, Minnesota, and Massachusetts. The industry sectors are: Construction, Special trade Contractors (SIC 17), Chemicals and Allied Products (28), Drugs (283), Fabricated Structural Metal Products (344), Electrical Components and Accessories (367), Surgical, Medical, and dental Instruments (384), Business Services (73), Computer Programming, Data Processing, and Software (737), Engineering, Accounting, Research, Management, and Related Services (87), and Research, Development, and Testing Services (873). The selected sectors represents a mix of traditional and high technology, and two- and three-digit (SIC) sectors. The selection of several traditional sectors allows us to see if the new economy indicators have any "crossover" value for projections beyond new technology sectors. The selection of both three- and constituent three-digit sectors allows us to see if the new indicators have comparatively greater value for aggregated or disaggregated sectors. The selection of the three states is not meant to be representative of all fifty states. Massachusetts, Minnesota, and Ohio all have notable concentrations of knowledge-based sectors in their respective state economies. Yet they differ in terms of their overall industry composition, including the size of traditional durable goods manufacturing sectors, and agricultural-based sectors, and metropolitan versus non-metropolitan distribution of economy activity.

The testing is based upon comparison of regression model results from three different model specifications for a given dependent variable (i.e., a particular industry sector). The three model specifications are:

(1) State industry employment (t) = f [national industry employment (t), state population (t)] ("BASE")
(2) State industry employment = f [national industry employment (t), new economy variable i (t)]; ("NEV")
(3) State industry employment (t) = f [national industry employment (t), state population (t), new economy variable i (t)]. ("BASE PLUS NEV")

These particular specifications are chosen on the hypothesis that the new economy variable would be a substitute (and superior) indicator of regional (state) competitiveness, an important theoretical factor for explaining state industry employment change for both export-oriented and local-serving sectors in the modeling structure of the Long-Term Industry Projection (LTIP) system (Goldstein, 2000). In this exploratory and heuristic testing strategy in which we developed and ran a large number of models, we have not attempted to develop fully-specified models, including cyclical fluctuations. Rather we have sought to suggest and identify the likelihood that including particular new economy indicators would improve the projection accuracy over the existing model specifications *typically* used in the LTIP system.

Model performance is evaluated using the following diagnostics: adjusted R^2, the Durbin-Watson (DW) statistic, and the statistical significance for the estimated coefficients (t-statistic). We compare these diagnostic criteria over the range of model specifications described above.

IV. Results of Empirical Testing

Overall, the inclusion of one of the new economy variables in the regression model improved the model's performance in tracking the dependent variable during the historical period in the majority of cases. This is especially so for the cases in which the dependent variable is not "well-behaved", i.e., with relatively low R^2 (less than 0.90), for the base model. In cases where the base model produces a high R^2, the inclusion of a new economy variable almost always improves the model performance, but the marginal gain is small.

The particular new economy variables that led to the best fitting models varied across the industry sectors and across states. In many cases, however, the differences between the "best" model and a number of others with alternative new economy variables are quite small. Tables 3-5 summarize the performance of models for the test industry sectors in the three states.

Table 3
Model Results for Massachusetts

	Base Model				NEV Model					Base Plus NEV				
SIC	**N**	**R^2**	**D-W**	**S/S?**	**N**	**R^2**	**D-W**	**S/S?**	**NEV**	**N**	**R^2**	**D-W**	**S/S?**	**NEV**
17	23	0.67	0.34	N	23	0.86	1.09	N	Doct Recip, SEH (-3)	23	0.90	1.19	N	Tot Univ, R&D/U.S. (-3)
					22	0.80	1.07	Y	Bach Degree, SEH/POP (-1)	23	0.89	1.38	N	Bach Degree (-2)
					23	0.87	0.81	Y	Tot Univ, R&D/U.S. (-3)					
28	23	0.02	0.66	N	23	0.69	1.64	N	Tot Univ, R&D/GSP (-1)	23	0.82	2.19	N	Pub Sch & Student (-5)
					23	0.63	1.54	N	Univ R&D, SEH/GSP (-1)	23	0.76	1.89	N	Tot Univ R&D (-3)
283	23	0.84	0.23	N	20	0.93	0.63	Y	Tot Univ R&D/GSP (-4)	23	0.95	1.26	N	Doct. Recip, SEH (-5)
					23	0.95	1.27	Y	Doct Recip, SEH/POP (-5)	23	0.96	1.35	N	Bach Degr, SEH/U.S. (-2)
344	23	0.28	0.44	N	12	0.82	2.06	N	Tot Ind R&D/U.S. (-4)	23	0.83	1.66	Y	Tot Univ R&D/U.S. (-2)
					23	0.77	1.15	N	Univ R&D, SEH/GSP (0)	23	0.83	1.31	N	Av Wage/Job/U.S (-4)
367	23	0.93	0.67	N	23	0.94	0.72	Y	Tot Univ R&D/U.S. (-3)	23	0.97	1.93	N	Bach Degr, SEH/POP (-3)
					23	0.91	1.57	Y	Univ R&D, SEH/U.S. (-2)	23	0.97	1.89	N	Doct Recip, SEH (-3)
384	23	0.91	0.69	N	18	0.93	1.30	Y	Tot Univ R&D/GPS (-6)	23	0.97	2.15	N	Tot Ind R&D (-6)
					23	0.95	1.19	Y	Grad Stud, SEH/POP (-6)	23	0.97	1.61	N	Doct Recip, SEH (-2)
73	23	0.97	0.29	N	18	0.98	1.59	Y	Univ R&D, SEH/GSP (-6)	23	0.99	1.47	Y	Tot Univ R&D/U.S. (-2)
					23	0.98	1.04	Y	Bach Degr, SEH/POP (0)	23	0.99	1.68	N	Av Wage/Job/U.S. (-2)
737	23	0.99	0.97	N	23	0.99	1.53	Y	Grad Stud, SEH/POP (-5)	23	0.99	2.01	Y	Tot Univ R&D/U.S. (-2)
					23	0.99	1.41	Y	Univ R&D, SEH/U.S. (-2)	23	0.99	1.89	N	Av Wage/Job/U.S. (-3)
873	23	0.98	0.95	Y	18	0.98	2.08	Y	Univ R&D, SEH,GSP (-6)	23	0.99	1.80	Y	Tot Univ R&D/U.S. (0)
					23	0.98	1.14	N	Tot Univ R&D/GSP (0)	23	0.99	1.82	Y	Univ R&D, SEH/U.S. (0)

N is the number of temporal observations.
R^2 is the adjusted R-squared.
D-W is the estimated Durbin-Watson statistic used to test for the presence of serial correlation.
S/S asks whether all independent variables are statistically significant; Y indicates yes, N indicates no.
Independent variable labels are explained in Appendix A.

Table 4
Model Results for Minnesota

	Base Model				NEV Model					Base Plus NEV				
SIC	N	R^2	D-W	S/S?	N	R^2	D-W	S/S?	NEV	N	R^2	D-W	S/S?	NEV
17	23	0.95	0.37	N	23	0.96	1.10	N	Univ R&D, SEH/U.S. (-5)	20	0.99	1.33	N	Tot Univ R&D/GSP (-4)
					19	0.99	1.39	Y	MFG VA/MFG Empl (0)	23	0.99	1.33	N	Bach Degr, SEH/POP (-5)
28	23	0.91	0.31	N	23	0.97	1.63	N	Tot Univ R&D (0)	23	0.99	1.62	N	Av Wage/Job (-4)
					23	0.97	1.59	N	Univ R&D, SEH/U.S. (0)	23	0.97	1.55	N	Tot Univ R&D (0)
					22	0.99	1.09	Y	Publ Sch & Student (0)					
283	23	0.82	0.55	N	12	0.96	1.59	N	Tot Ind R&D	23	0.96	1.89	N	Av Wage/Job (-5)
					23	0.92	1.56	Y	Av Wage/Job/U.S. (-5)	13	0.96	1.49	N	Tot Ind R&D (-5)
344	23	0.87	1.05	Y	23	0.92	1.39	Y	Univ R&D, SEH(-5)	23	0.94	2.12	N	Tot Univ R&D (-5)
					23	0.91	1.38	Y	Tot Univ R&D (-5)	19	0.94	2.22	Y	Tot Univ R&D/GSP (-5)
367	23	0.82	0.37	Y	23	0.93	1.47	Y	Av Wage/Job/U.S. (-6)	23	0.95	2.26	N	MFG VA/MFG Empl (-6)
					23	0.92	1.27	Y	MFG VA/VAL Ship (-1)	23	0.95	1.54	Y	Av Wage/Job/U.S. (-5)
384	23	0.99	0.73	N	22	0.99	0.76	Y	Univ R&D, SEH (-6)	18	0.99	1.43	Y	Tot Univ R&D/GSP (-6)
					23	0.98	1.51	Y	Doct Recip, SEH/POP (-6)	23	0.99	1.39	Y	Doct Recip, SEH/POP (-6)
					23	0.97	1.18	Y	Grad Stud, SEH/U.S. (-5)					
73	23	0.99	1.17	Y	19	0.99	2.00	Y	Tot Univ R&D/GSP (-5)	23	0.99	2.15	N	Tot Univ R&D (-5)
					23	0.99	2.04	Y	Doct Recip, SEH/POP (-2)	19	0.99	1.94	Y	Univ R&D, SEH/GSP (-5)
737	23	0.99	0.88	N	23	0.99	1.82	Y	Tot Univ R&D/GSP (-6)	23	0.99	1.74	N	Univ R&D, SEH/GSP (0)
					23	0.99	1.45	Y	Grad Stud, SEH/POP (-4)	23	0.99	1.74	N	Bach Degr, SEH/U.S. (-4)
87	13	0.98	0.91	N	13	0.99	1.84	N	Grad Stud, SEH/U.S. (-1)	13	0.99	1.90	N	Tot Univ R&D/GSP (-5)
					13	0.99	1.74	Y	Av Wage/Job/U.S. (0)	13	0.99	1.98	Y	Av Wage/Job/U.S. (0)
873	23	0.86	0.88	N	23	0.90	1.19	N	Grad Stud, SEH/POP (-1)	23	0.93	1.52	N	Univ R&D, SEH (0)
					23	0.88	1.20	N	Tot Univ R&D/GSP (-1)	23	0.89	1.15	N	Bach Degr, SEH/POP (-4)
					23	0.88	1.16	Y	Av Wage/Job/U.S. (-1)					

Table 5
Model Results for Ohio

	Base Model				NEV Model					Base Plus NEV				
SIC	N	R^2	D-W	S/S?	N	R^2	D-W	S/S?	NEV	N	R^2	D-W	S/S?	NEV
17	29	0.91	0.40	Y	19	0.95	1.77	Y	Tot Ind R&D/U.S. (-2)	13	0.96	1.34	N	Mfg VA/Mfg Empl (-3)
					16	0.97	1.68	Y	Mfg/VA/Mfg Empl (-4)	14	0.96	1.52	N	Mfg VA/Val Ship (-2)
28	31	0.82	0.88	Y	29	0.82	1.39	Y	Tot Univ R&D/U.S. (0)	20	0.89	1.80	N	Univ R&D, SEH/GSP (-4)
					31	0.81	1.03	Y	Doct Recip, SEH (-3)	23	0.87	1.32	N	Grad Stud, SEH/POP (-5)
283	29	0.79	0.64	N	20	0.90	1.66	N	Tot Ind R&D/U.S. (-6)	20	0.91	1.94	N	Tot Ind R&D/U.S. (-6)
					19	0.83	1.55	N	Tot Ind R&D (-2)	20	0.89	1.45	N	Univ R&D, SEH (0)
344	29	0.75	0.15	N	16	0.90	1.37	N	Mfg VA/Mfg Empl (-4)	19	0.96	1.98	N	Tot Ind R&D/U.S. (-2)
					19	0.87	1.26	Y	Tot Ind R&D/U.S. (-2)	29	0.98	1.49	N	Bach Degr, SEH/U.S. (-5)
384	26	0.89	0.51	N	16	0.93	1.41	Y	Tot Ind R&D (-4)	26	0.95	1.19	N	Tot Univ R&D/U.S. (-1)
					24	0.96	1.12	Y	Bach Degr, SEH/POP (0)	24	0.96	1.14	N	Bach Degr, SEH (0)
73	31	0.99	0.29	N	16	0.99	1.32	Y	Mfg VA/Mfg Empl (-4)	14	0.99	1.81	N	Mfg VA/Val Ship (-6)
					21	0.99	1.15	Y	Tot Ind R&D (-3)	26	0.99	1.47	N	Av Wage/Job/U.S. (-5)
737	29	0.99	0.56	Y	19	0.99	1.45	Y	Tot Ind R&D (-5)	20	0.99	1.80	N	Tot Ind R&D (-3)
					29	0.99	1.42	Y	Doct Recip, SEH/POP (0)	15	0.99	1.37	N	Mfg/VA Mfg Empl (-5)
87	13	0.98	0.72	N	13	0.99	1.38	Y	Bach Degr, SHE (-2)	13	0.99	1.87	N	Av Wage/Job (-2)
					13	0.98	1.32	N	MFG VA/Mfg Empl (-2)	13	0.99	1.83	N	Mfg VA/Mfg Empl (-6)
873	22	0.81	0.35	N	22	0.89	1.04	N	Tot Univ R&D/GSP (-1)	18	0.93	1.70	N	Tot Univ R&D/GSP (-6)
					13	0.87	1.70	N	Tot Ind R&D/U.S. (-4)	22	0.88	1.58	N	Doct Recip, SEH (-4)
					22	0.78	0.56	Y	Av Wage/Job/U.S. (-3)					

V. Conclusions and Recommendations

The results of the empirical tests suggest that states may be able to find better fitting models with the inclusion of an alternative measure of state competitiveness for a number of industry sectors. Specifically, variables that take into account the relative strength of a state's relative knowledge base, or knowledge capacity, may help to explain long-term changes in industry employment. This improvement in explanatory power of the models is not limited to just high tech sectors, but seems to carry over to the traditional sectors as well.

There were a variety of new economy indicators whose inclusion in the models led to improved model fit. Yet, there is no obvious *a priori* way to know which indicator is likely to perform the best for modeling a particular industry sector in a given state. Moreover, results vary when we introduce different length of lags for the new economy variables, and theory does not serve as a useful guide for selecting the "correct" lag. All in all, based upon our experiments, there would appear to be a lot of trial and error in selecting the best new economy indicator, as there is a high degree of colinearity among many of the new economy variables. This implies that if new economy indicators are added to the LTIP system, there should be a variety of perhaps five or six to choose from, and each with a variety of length of lags.

The tests we have performed to evaluate whether the inclusion of new economy indicators improved model performance were not based upon projection performance, but instead upon model fit during the calibration period. While improved fit during the calibration period is a good indicator of improved projection performance, it is not a guarantee. There are several reasons why they do not always go in the same direction. One is because error in the exogenous projection of the independent variables can lead to increased projection error. In this context we need to consider how projections of the new economy variables will be developed and how accurate they are likely to be. To our knowledge, the new economy variables presently are not being projected by either the national or state levels by a federal government agency. It is possible, though unlikely, that economic research organizations based in universities or think tanks may be projecting these. So we should assume that either state LMI staff would have the responsibility of developing exogenous projections of the new economy variables, or else the Projections Workgroup would contract with a state or consultant to develop them. There are a number of techniques that could be used for developing such projections, but some variant of trend analysis or curve fitting would be the most likely. It is difficult to assess in the absence of ex-post projection tests how accurate the projections would be. Some of the new economy indicators would seem to display low volatility while others are likely to be quite volatile. The likely volatility of the variables would be an important consideration in the selection of which ones to utilize.

As a caveat, the empirical tests we have performed use SIC-based annual employment data. There is no *a priori* reason to believe that the results we obtained would have been affected by the use of NAICS data, although we can not verify that. The main implication of the conversion to NAICS is that the length of the annual time-series for regression models may be shorter in a number of cases, reducing the degrees of freedom and consequent precision of estimate of parameters and of projections of the dependent variable. But including a measure of state comparative advantage based upon new economy concepts in regression models as a substitute for the more traditional indicators will not in itself reduce the number of degrees of freedom.

The additional time costs of adding variables and modeling options are also a consideration. Once the variables and their projected values are in the LTIP's data base the additional state LMI staff time is only marginal. There are, however, development costs for programmers on the Utah LMI staff to add new modeling options to the LTIP software. There are small costs of adding annual values to the data base, but substantial time costs of projecting values, as discussed above.

There are potential benefits of having the new economy variables included in the LTIP system in terms of improving projection accuracy, but there are also costs. Do the benefits exceed the costs?

My recommendation would be provide the capacity to add a small number of new economy variables to the data set and to introduce several new model options in the regression portion of the LTIP system (see Table 6). This still leaves the Projections Workgroup the option of taking responsibility of providing the data and projected values, or letting each state decide if it wants to add the data and develop projected values for any new economy variables it wishes to include in regression models.

Table 6
Recommended New Economy Variables

1. Total Industrial R&D Investments as Percent of Nation (lagged) (in constant $).

2. University R&D in Science, Engineering and Health as Percent of Nation (lagged) (in constant $).

3. Bachelor Degrees, SHE, Awarded Per Capita, (lagged) or Percent of Population with Bachelor's Degrees

4. Average Wage/Salary per Job (constant $).

Appendix A

Industrial R&D Investment.

Years: 1963-1977 (annual). !977-1997 every other year. 1998 on – annual.
Geographic coverage: States, nation.
Potential disaggregation: By industry sector
Source: NSF, Industrial Research and Development System (IRIS) reports (in current $).
Preferred projection technique: Shift-share or time-series regression.

SBIR/STTR Awards (Number and Dollars)

Years: 1983 --
Geographic coverage: States, nation
Potential disaggregation: SBIR awards, STTR awards.
Source: Small Busioness Administration (SBA), SBIR/STTR administrative records. Available from SBA website.
Projection: Shift-share for STTR; Shift-share or Time-series regression for SBIR.

University R&D Funding.

Years: 1972 --
Geographic coverage: States, nation.
Potential disaggregation: By source of funding; by academic discipline
Source: NSF, Survey of Scientific and Engineering Expenditures at Universities and Colleges. WebCaspar (in current $).
Projection: Time-series regression.

University Science and Engineering Grad Students

Years: 1972 –
Geographic coverage: States, nation.
Potential disaggregation: By academic discipline.
Source: NSF and NIH Survey of Graduate Students and Postdoctorates in Science and Engineering.
Projection: Time-series regression.

Doctoral Recipients

Years: 1966 –
Geographic coverage: States, nation.
Potential disaggregation: By academic discipline.
Source: University of Chicago National Opinion Research Center, Survey of Earned Doctorates. WebCaspar.
Projection: Time-series regression.

Degrees Awarded

Years: 1966-1998, 2000 –
Geographic coverage: States, nation
Potential disaggregation: By academic discipline and by degree level.
Source: National Center for Education Statistics (NCES), Intehrated Postsecondary Educational Statistics (IPED). WebCaspar.
Projection: Time-series regression.

Enrollment in Four-Year Institutions
Years: 1970 –
Geographic coverage: States, nation.
Source: NCES, IPEDS. Reported in the Digest of Education Statistics and through NCES website: nces.ed.gov.
Projection: Time-series regression**.**

Public School Funding Per Student
Years: 1970 –
Geographic coverage: States, nation
Source: NCES, Common Core of Data (CCD) series. Reported in the Digest of Education Statistics (in current $).
Projection: Time-series regression

Average Annual Public School Teacher Salary
Years: 1970 –
Geographic coverage: States, nation
Source: NCES, Common Core of Data (CCD). Reported in Digest of Education Statistics (in current $).
Projection: Time-series regression

Gross State Product
Years: 1977 –
Geographic coverage: States.
Potential disaggregation: By major industry division**.**
Source: Bureau of Economic Analyis website (in millions of current $).
Projection: Shift-share; Time-series regression

Average Wage/Salary Per Job
Years: 1969 –
Geographic coverage: States, nation.
Source: Bureau of Economic Analysis, REIS website (in current $).
Projection: Time-series regression.

Manufacturing Value-Added
Years: 1970 --
Geographic coverage: States, nation
Potential disaggregation: By detailed manufacturing sectors.

Source: Census of Manufacturers, Annual Survey of Manufactures (in millions of current $).
Projection: Time-series regression

Value of Shipments
Years: 1970 --
Geographic coverage: States, nation
Potential disaggregation: By detailed industry sector
Source: Census of Manufactures, Annual Survey of Manufactures (in millions current $).
Projection: Time-series regression

Patents Granted, Number of Utility
Years: 1963 --
Geographic coverage: States, nation.
Potential disaggregation: By technology category.
Source: U.S. Patents and Trademark Office (USPTO). Available from National Bureau of Economic Research (NBER).
Projections: Time-series regression (but volatile).

Firm Births, etc
Years: 1988 –
Geographic coverage: States, nation
Potential disaggregation: Births, failures, bankruptcies, incorporations
Source: SBA, Office of Advocacy. Available from Small Business Indicators Reports, SBA website.
Projections: Shift-share

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