ECONSTOR
Make Your Publications Visible.

A Service of
ZBW
Leibniz-Informationszentrum Wirtschaft
Leibniz Information Centre for Economics

Jeon, Yongbok; Vernengo, Matías

Working Paper

Puzzles, paradoxes and regularities: Cyclical and structural productivity in the US (1950 - 2005)

Working Paper, No. 2007-07

Provided in Cooperation with:
Department of Economics, The University of Utah, Salt Lake City

Suggested Citation: Jeon, Yongbok; Vernengo, Matías (2007) : Puzzles, paradoxes and regularities: Cyclical and structural productivity in the US (1950 - 2005), Working Paper, No. 2007-07, The University of Utah, Department of Economics, Salt Lake City, UT

This Version is available at:
https://hdl.handle.net/10419/64450

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

WWW.ECONSTOR.EU

Mitglied der Leibniz-Gemeinschaft

DEPARTMENT OF ECONOMICS WORKING PAPER SERIES

Puzzles, Paradoxes and Regularities: Cyclical and Structural Productivity in the US (1950-2005)

Yongbok Jeon
Matías Vernengo

Working Paper No: 2007-07

University of Utah
Department of Economics
1645 East Central Campus Dr., Rm. 308
Salt Lake City, UT 84112-9300
Tel: (801) 581-7481
Fax: (801) 585-5649
http://www.econ.utah.edu

Puzzles, Paradoxes and Regularities: Cyclical and Structural Productivity in the US (1950-2005)

Yongbok Jeon
University of Utah, Department of Economics

Matías Vernengo
University of Utah, Department of Economics

Abstract

Changes in labor productivity have been a source of puzzlement and paradoxical results for economists. We suggest that puzzles and paradoxes vanish once two simple regularities are properly acknowledged. Okun and Verdoorn's Laws explain 87 percent of all the variations in labor productivity. Also, our estimation method and our results suggest that conventional measures of Okun's Law have overestimated the value of the Okun coefficient, and accepted a greater degree of variability than is actually guaranteed by the empirical evidence. Okun's Law has been relatively stable through time, and there is no significant decrease in the value of the parameter since the 1960s.

Keywords: E320, O490, O510
JEL Classification: Productivity, Cycle, Structural Change

Acknowledgements: We would like to thank to Per Berglund, who was instrumental in the development of the most consequential ideas in the paper. Responsibility for any mistakes is entirely ours.

1. Introduction

According to conventional wisdom, labor productivity growth has been a source of puzzlement and paradoxical results. The labor productivity slowdown of the early 1970s is well known as the "productivity slowdown puzzle," and several authors suggest that its causes have not been completely identified. The 1990s intensified the sense of bewilderment. The revival in U.S. productivity growth after 1995 has led many authors to suggest that there is a "New Economy" based on information technology (IT). The idea is that the productivity payoff of the IT investments were delayed because of lags in adopting software and business practices associated to the rapid improvements in IT hardware capability of the previous decades.

For example, William Nordhaus (2005) finds that the productivity rebound since 1995 has been pervasive, with approximately 40 percent of it taking place in sectors related to the "New Economy." Paradoxically, at least in Nordhaus view, he also finds that more rapid productivity growth leads to increasing rather than decreasing employment in manufacturing.

Almost all discussions tend to suggest that explanations for the collapse or surge in productivity growth must be related to the supply side.[1] Important as cyclical effects are, we believe that long term structural effects of output growth on productivity, which we suggest are associated with Verdoorn's Law, are also part of the story.

This paper argues that there are two significant problems with conventional wisdom on productivity growth. First, the omission of structural effects leads to an

[1] One exception is Gordon (2000) who emphasizes the cyclical component of productivity generally associated with Okun's Law.

overestimation of the Okun coefficient. Second, once cyclical and structural effects are taken into account there is little role for puzzles and paradoxes in explaining productivity growth. In fact, regularities explain a staggering 87 percent of the changes in productivity. Next section presents our main results, and the last section summarizes the implications.

2. Okun and Verdoorn Laws

The traditional representation of Okun's Law[2] says that if the economy grows above the potential growth rate unemployment will fall, but less than proportionally, since productivity is pro-cyclical. We have:

(1.) $$(g - g_p) = -\alpha \Delta u$$

where g and g_p are the real rate of GDP growth and potential GDP growth respectively, Δu is the change in the unemployment level, and α is the Okun coefficient. Okun's Law is usually represented as a time series relation in a given economy.

Verdoorn's Law suggests that productivity growth is a function of the rate of growth of manufacturing production.[3] A more encompassing version would suggest that productivity growth results from total output growth, or in Adam Smith's famous dictum: "the division of labor depends on the extent of the market." We have:

[2] See Arthur Okun (1962).

[3] See Johannes P. Verdoorn (1949) and Nicholas Kaldor (1966).

(2.) $$p = \beta + \gamma g_p$$

where p is the rate of labor productivity growth, β is the autonomous increase in productivity, and γ is the Verdoorn coefficient. Note that, in this version, we presume that it is the long term potential growth of GDP that puts pressure on the economy, and forces the process of 'creative-destruction' associated with productivity growth. The reason for that is that Verdoorn's Law is usually measured in a cross section of countries, and averaging output growth over long periods eliminates the effects of cyclical variations.

This formulation of Okun and Verdoorn's Laws suggest that the former should be interpreted as a cyclical effect of output on productivity, while the later should be seen as a structural or trend effect. Further, we believe that estimates of Okun's Law have been biased because of the tendency of omitting Verdoorn's Law, which would lead to overstate the value of the Okun parameter.[4] This paper tries to estimate both effects eliminating the bias in conventional estimates of Okun's Law.

Substituting (1.) into (2.) we obtain:

(3.) $$p = \beta + \gamma(g + \alpha\Delta u)$$

Rearranging we get:

[4] An exception is the study by Huang and Lin (2006) that separates the cyclical and trend effects of output growth on unemployment. Verdoorn's Law measures have not suffered the problem since they often average long periods, hence eliminating cyclical variation.

(4.) $$p = \beta + \gamma g + \gamma\alpha\Delta u$$

To solve the omitted variable problem we do a partitioned regression, and obtain a residual Δu series that is not correlated with the rate of output growth, which we call Δu^*. It is important to note that the unobservable potential growth rate is eliminated in this specification, and that once we obtain the Verdoorn coefficient we can derive the Okun one.

The econometric results are presented in Table 1, which show a Verdoorn coefficient of approximately 0.63 and an Okun coefficient of around 1.69.[5] As expected the Okun coefficient is smaller than what is usually found in the literature (closer to 2). The simple explanation is that part of what is usually assumed to be explained by Okun's Law, a cyclical effect, is actually the result of trend or structural effects, that is, caused by Verdoorn's Law.

The parameters are robust to different specifications, and more interestingly, are quite stable even for different sub-periods. In other words, if productivity fell in the 1970s and recovered in the mid-1990s it must be because of changes in output growth, and not changing parameters. Hence, our results suggests that the Okun coefficient has

[5] For the Okun coefficient we divide the coefficient for Δu^* ($\gamma\alpha$) by the Verdoorn coefficient (γ). Augmented Dickey-Fuller tests show that labor productivity and output growth are not integrated, ruling out the possibility of a spurious regression. All the coefficients, except the constant, are significant at the 1 percent level.

been remarkably constant, in contrast to conventional claims that suggest a reduction from around 3 to close to 2.

Table 1: Regression Results[6]

Dependent Variable: P
Method: Least Squares
Sample (adjusted): 1951 2005
Included observations: 55 after adjustments
Convergence achieved after 6 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.356941	0.223076	-1.600089	0.1158
G	0.625842	0.032122	19.48320	0.0000
ΔU*	1.069260	0.145355	7.356206	0.0000
AR(1)	0.554642	0.117267	4.729753	0.0000

R-squared	0.875715	Mean dependent var	1.690311
Adjusted R-squared	0.868404	S.D. dependent var	1.813996
S.E. of regression	0.658049	Akaike info criterion	2.070872
Sum squared resid	22.08445	Schwarz criterion	2.216860
Log likelihood	-52.94898	F-statistic	119.7820
Durbin-Watson stat	2.072422	Prob(F-statistic)	0.000000

Inverted AR Roots	.55

The conventional interpretation of Okun's Law is that there is a supply capacity limit. In other words, if the economy grows significantly above its potential, then unemployment

[6] The Jarque-Bera goodness of fit test shows no departure from normality. Also, the Ramsey RESET test verifies no mis-specification, while the White's test does not reject the null hypothesis of no heterocedasticity at the 5 percent level. Finally, the equation is estimated with an AR(1), since the Durbin-Watson test is in the indeterminate region. After adjusting to AR(1) the model passes all diagnostic tests, and, more importantly, the estimated coefficients are not significantly different, with imperceptible changes in their sizes.

will eventually fall below the natural rate, and inflationary pressures will develop. In fact, the conventional view suggests that supply changes affect the labor market equilibrium, and this, in turn, determine the non-inflationary limit to economic expansion. This view of a supply constraint is the basis of the natural rate of unemployment or the Non Accelerating Inflation Rate of Unemployment (NAIRU).

A more Keynesian reading, and probably closer to Okun's (1962) intentions, would suggest that, in order to achieve a certain unemployment target, growth should be above its trend by a certain magnitude. In other words, Okun's Law can be seen as an empirical regularity that can be exploited for policy purposes. Demand expansion does not lead directly to inflation, since it has a positive cyclical effect on productivity.[7]

Further, Kaldor's interpretation of Verdoorn's Law reinforces the demand-oriented interpretation of Okun's Law. Kaldor (1966) suggested, following Adam Smith, that greater labor productivity resulted from output growth, and that this reflected a process of circular and cumulative causation or increasing returns to scale. Okun and Verdoorn's Law interpreted in this way imply that the notion of a relative stable supply limit to the economy is at least questionable.

The Keynesian interpretation suggests that both Okun and Verdoorn's Laws imply causality from output growth to labor productivity, while conventional wisdom would suggest reverse causation. In other words, Okun's Law results from labor hoarding, that is, causality goes from output variations to the labor market, and then to

[7] Also, higher labor productivity increases the space for non-inflationary wage increases. It must be noted that lower unemployment may increase labor bargaining power and indirectly lead to wage pressures beyond the increase of productivity, and as a result to higher inflation.

productivity. In the same vein, Verdoorn's Law implies that a system that is growing fast is forced to innovate in order to maintain its pace. As the old dictum states: necessity is the mother of invention.

Causality is difficult to ascertain, and our econometric analysis does intend to shed light on the issue.[8] However, there is little evidence for a constant or even relatively stable NAIRU. In other words, if the expansion of the economy – both its cyclical and structural components – leads to increasing productivity, than the supply limit is affected by the expansion of demand. This has been underscored by the increasing acceptance of a time varying NAIRU (TV-NAIRU).[9] The variability of the NAIRU – and the related idea of an exogenous potential GDP – undermines the supply interpretation of Okun's Law. If a reduction in the current rate of unemployment reduces the natural rate of unemployment, then the economy can grow without the risk of accelerating inflation.

In this light, our econometric results have serious implications for the interpretation of the 'productivity slowdown puzzle' of the early 1970s, and the 'New Economy' of the mid-1990s. They are essentially explained by the same phenomena. The slowdown was associated to the contractionary macroeconomic policies implemented as a result of the acceleration of inflation.[10] These policies were maintained

[8] We do not provide a fully consistent stock-flow model in which Okun and Verdoorn's Laws are consistently integrated in this paper. For a complete model consistent with our discussion of Okun and Verdoorn's Laws see Berglund (2006).

[9] For a devastating theoretical and empirical critique of the stable NAIRU see Robert Eisner (1997).

[10] Although not central to our argument, it is important to note that contrary to conventional wisdom that suggests that the Great Inflation of the 1970s was caused by demand pull pressures, we believe that cost

in spite of the significant increase in unemployment. The justification for accepting higher levels of unemployment was that the NAIRU had increased steadily from slightly above 3 to around more than 6 percent. The side effect of an economy with, on average, higher levels of unemployment was the slowdown of labor productivity.

James Galbraith (1997, p. 99) correctly points out, referring to the macroeconomic policies that followed the Great Inflation, that "erring policymakers have in the past reacted imprudently to 'supply shocks' in ways that prematurely and systematically curtailed economics expansion." Galbraith argues that business cycles peaks and valleys are endogenous to policy. We would add the trend too. In other words, the misperception about the causes of inflation in the 1970s led to contractionary policies that had negative cyclical and trend effects on output, and as a result of Okun and Verdoorn's Laws on labor productivity.

The same can be suggested about the 'New Economy.' In other words, the expansion that started during the Clinton administration, and the willingness of the Federal Reserve not to increase interest rates when unemployment fell below what was accepted as the correct level of the natural rate, was central for the labor productivity recovery.[11] There is nothing particularly different between the increase in productivity growth in the 1960s, associated with the Keynesian "New Economy" and the "New Economics" of the 1990s. Both are related to the expansion of output growth, and

---

push forces, associated with the oil shocks and the depreciation of the dollar, were more important. In that respect, contractionary demand was not central for stabilization as much as a reversal of cost conditions.

[11] This does not imply that the Clinton boom was devoid of problems. First, the recovery did little to improve income distribution, and it was based, to a great extent, on the "dot.com" bubble. For a critique of the Clinton years see Robert Pollin (2003).

whereas the two expansions have certainly had different effects on income distribution, both, through Okun and Verdoorn's Laws, had a positive impact on labor productivity.

Also, IT is considerably less relevant than usually assumed. It is clear that when productivity picks up the technologies that are used (and improved) are those that are already available. Hence, before the 1990s computers were visible everywhere but in productivity statistics, as Robert Solow (1987) famously put it, because output growth was slow, but as soon as it expanded in the mid-1990s they became quite ubiquitous. Solow's paradox is also explained by two simple regularities.

Also, our discussion of Okun and Verdoorn's Laws has important implications for current macroeconomic policies. First, it seems reasonable to assume, given the established regularities, that as the recovery from the last recession has been relatively weak when compared to the other post-war recoveries, then eventually labor productivity will slowdown, more so if the economy enters a recession, or accommodates to lower rates of growth on average. This is, in fact, something that is already visible in the recent evolution of labor productivity.

In terms of monetary policy Okun and Verdoorn's Laws suggest that the trade-offs confronted by the Federal Reserve are not as clear-cut as often argued. In fact, an anti-inflationary stance that induces lower levels of activity, would have a negative impact on labor productivity, and increase the risks of demand pull inflation, without necessarily affecting cost pressures. Our estimates cannot determine how optimal monetary policy would look like, and we have no intention of arguing one way or another. However, Okun and Verdoorn's Law imply that the supply limits to the

economy are to some degree endogenous and this should be introduced into policy discussions.

3. Concluding Remarks

Changes in labor productivity have been a source of puzzlement and paradoxical results for economists. We suggest that puzzles and paradoxes vanish once two simple regularities are properly acknowledged. Okun and Verdoorn's Laws explain 87 percent of all the variations in labor productivity. In other words, the cyclical and structural effects of the variations in output growth account for almost all the change in labor productivity.

In addition, our estimation method and our results suggest that conventional measures of Okun's Law have overestimated the value of the Okun coefficient, and accepted a greater degree of variability than is actually guaranteed by the empirical evidence. Okun's Law has been relatively stable through time, and there is no significant decrease in the value of the parameter since the 1960s.

Last but not least, our results suggest that the cyclical variation and the trend of labor productivity are to some degree endogenous to macroeconomic policy. In our view, this has serious implications for the conduction of macroeconomic policy. A thorough discussion of the implications goes beyond the scope of our paper, but we believe that the recognition of the importance of Okun and Verdoorn's Laws should reinforce the increasing skepticism about the NAIRU and the very notion of a rigidly fixed supply limit to the economy.

References:

Berglund, P. G. (2006), "Paradox of thrift and budget in a simple Keynesian growth model," in P. G. Berglund and M. Vernengo (eds.), *The Means to Prosperity*, New York: Routledge.

Eisner, R. (1997), "A new view of the NAIRU," in P. Davidson and J. Kregel (eds.), *Improving the Global Economy*, Cheltenham: Edward Elgar.

Galbraith, J. (1997), "Time to Ditch the NAIRU," *Journal of Economic Perspectives*, 11(1), pp. 93-108.

Gordon, R. (2000), "Does the 'New Economy' Measure up to the Great Inventions of the Past?" *Journal of Economic Perspectives*, 14(4), pp. 49-74.

Huang, H-C. and S-C. Lin (2006), "A flexible nonlinear inference to Okun's relationship," *Applied Economics Letters*, 13(5), pp. 325-31.

Kaldor, N (1966), "Causes of the slow rate of economic growth in the United Kingdom," in F. Targetti and A. P. Thirlwall (eds.) *The Essential Kaldor*, London: Duckworth, 1989.

Nordhaus, W. (2005), "The sources of the productivity rebound and the manufacturing employment puzzle," *NBER Working Paper* No 11354.

Okun, A. (1962), "Potential Output: Its Measurement and Significance," in American Statistical Association, *Proceedings of the Business and Economics Section*, Washington, D.C.: American Statistical Association.

Pollin, R. (2003), *Contours of Descent*, New York: Verso.

Solow, R. (1987), "We'd better watch out," *New York Times Book Review*, (July 12), 36.

Verdoorn, J. P. (1949), "On the Factors Determining the Growth of Labor Productivity," in L. Pasinetti (ed.), *Italian Economic Papers*, Vol. II, Oxford: Oxford University Press, 1993.