Capital and Labor in the Long-Run: Evidence from Tobin's *q* for the U.S.

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Abstract: This paper assesses different measures of Tobin's *q* on the U.S. labor market over 1948-2002. We find a negative long-run relationship between the unemployment rate and Tobin's *q*, which is consistent with capital and labor being complements in production.

Keywords: capital, labor, long-run, unemployment rate, Tobin's q.

JEL Classification Codes: E22, E24, J64.

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1. Introduction

Tobin's q is defined as the ratio between the stock-market valuation of existing capital assets and its current replacement cost.[1] The theory put forward by Tobin (1969, 1998) proposes that a firm invests in capital when q is above its par value (1 for simplicity). Although Tobin (1998) recognizes that the influence of the financial markets on real investments is mostly indirect, one must expect an impact of Tobin's q on labor employment. The reason is straightforward. Considering that capital and labor are complements in the production function, a q value above par leading to an increase in the capital stock must lead to higher labor demand and employment. However, if one assumes, as Ricardo (1821) [see also Samuelson, 1988], that technical progress is primarily labor saving and that new capital will reduce the demand for labor permanently, one must expect a negative relationship between Tobin's q and employment.

Therefore, if Tobin's q affects the stock of capital, it must influence labor employment and then the unemployment rate. If capital and labor are complements (substitutes), higher q leads to more capital, and to more (less) labor and less (more) unemployment. While several studies have addressed the effects of Tobin's q on investment [see Cummins et al. (2006) for new results], none has examined its effects on the labor market. We attempt to fill this gap. This paper assesses the relationship between Tobin's q and the unemployment rate for the U.S. during the period 1948-2002. Measures of Tobin's q calculated by Laitner and Stolyarov (2003) and subsequently adjusted by Wright (2004, 2005) are examined. Applying the Pesaran et al. (2001) methodology to the unemployment rate and Tobin's q, a long-run and negative relationship is found for the U.S., which is consistent with capital and labor being complements in production.

[1] For the neoclassical approach see, e.g., Summers (1981) and Hayashi (1982).

2. The Data

The civilian unemployment rate in the U.S (**u**) started to be recorded by the Bureau of Labor Statistics (BLS) in 1948. As the original series is of monthly frequency, we average them out in order to get the annual unemployment rate. Figure 1 reproduces its pattern. Its mean is 5.64% as presented in Table 1. The series is seasonally adjusted (code: UNRATE) from the FRED database of the Federal Reserve Bank of St. Louis (http://www.frbstlouis.com/).

The data on Tobin's *q* for the U.S. is explained in Wright (2004), who in Wright (2005) corrects the series in Laitner and Stolyarov (2003) that had been well above 1. **qbea** is Tobin's *q* using only tangible assets in the denominator, with only net liabilities in the numerator.[2] The second measure (**qtot**) uses total assets in the denominator and gross liabilities in the numerator. "Equity *q*" (**qequ**) is defined by market value of equities/net worth.

As Figure 2 shows, the measures in Wright (2004, 2005) are very strongly correlated. For the 1948-2002 sample, the correlation coefficients between (qbea, qequ) is 0.996; between (qbea, qtot) is 0.992; and between (qbea, qtot) is 0.999. The correlation coefficients between these *q* measures and the unemployment rate vary from -0.232 to -0.299. Equity *q* is the most volatile and Tobin's *q* based on total assets the least. We use in the estimations below the series that lie between the two, **qbea**, which is Tobin's *q* with BEA-consistent tangible assets. It is a downward translation of Tobin's *q* calculated by Laitner and Stolyarov (2003) for the 1953-2000 sample, which we call **qls**.

[2] Tobin's average *q* is *q* = (market value of equities + liabilities)/total assets.

3. Results

Preliminary Granger causality tests support the main hypothesis of this paper as **qbea** "Granger causes" **u** and **u** does not "Granger cause" **qbea**.[3] Employing several approaches to detect unit roots, it is not possible to reach the same inference regarding the stationary pattern of the series. The unit root tests, available upon request, suggest Tobin's *q* follows an I (1) process in general. The unemployment rate series is likely to be I (0). In view of these results, we employ the ECM-type methodology proposed by Pesaran et al. (2001)[4]:

$$\Delta u_t = \alpha_0 + \alpha_1 t + \varphi u_{t-1} + \Psi x_{t-1} + \sum_{j=1}^{p-1} \beta_{uj} \Delta u_{t-j} + \sum_{j=1,}^{q-1} \beta_{xj} \Delta x_{t-j} + \omega \Delta x_t + \varepsilon_t \qquad (1)$$

where: u_t means the unemployment rate and x_t means any of the *q* series in turn. We choose the lag length (p, q) by Akaike and Schwarz information criteria. We also perform the estimation of (1) in reverse causation order. We estimate (1) by ordinary least squares and calculate the F-statistic for the null of $\alpha_1 = \varphi = \Psi = 0$. Under the alternative, $\alpha_1 \neq 0$, $\varphi \neq 0$, and $\Psi \neq 0$ represent a stable long-run relationship between u_t and $qbea_t$. The distribution of the statistic under the null depends on the order of integration of u_t and $qbea_t$.

Table 2 provides the results of this procedure. The time trend is always statistically significant, which leads us to prefer such specifications. We start with 4 lags

[3] F-statistics for **u** does not Granger causing **qbea** are: 0.65 (4 lags); 0.49 (3 lags); 0.07 (2 lags); and 0.39 (1 lag). For **qbea** does not Granger causing **u** the F-values are: 5.65 (4 lags); 5.36 (3 lags); 7.63 (2 lags); and 4.13 (1 lag), supporting unidirectional evidence.

[4] Applications of the methodology appear in several areas, including on monetary policy by Aksoy and León-Ledesma (2005) and on immigration and economic growth by Morley (2006).

and apply AIC and SIC information criteria. With **u** as dependent variable first, we resort to diagnostics and stability tests in other to decide between the 1 lag model and 3 lags model. Their major difference occurs in the CUSUM test of stability of coefficients. As reported in Table 3, CUSUM tests report an excellent pattern overall for the 1 lag. For 3 lags, there is one surpass of the lower band around 1979, a year associated in the U.S. with changes in monetary policy. The CUSUM of squares test displays a perfect record of stability within the two bands and is omitted from the table. Given that the CUSUM test is substantially better for 1 lag, we take that as our preferred specification.

There is no serial correlation in (1) according to Table 3. More importantly, we definitely reject the null that **u** and Tobin's *q* are unrelated in the long-run (F = 6.083) for the F-IV specification under 1 lag selected by SIC.[5] When **qbea** is the dependent variable the no-cointegration result is observed: all lower part F and t-values are consistently below the critical values in Table 2. The long-run coefficients in Table 3 indicate a statistically significant coefficient for the trend and a negative and statistically significant ψ-coefficient of -1.815 for the qbea. This suggests that increases in Tobin's q lead to reductions in the unemployment rate, which supports the hypothesis of capital and labor being complements for the post-war U.S. economy.

There is also the possibility that the Tobin's *q* corrected by Wright (2004, 2005) is not necessarily its "true" value. We thus calculate the long-run relationship with the **qls** derived by Laitner and Stolyarov (2003). The results, as one would suspect from the translation of measures discussed earlier, are unchanged.

[5] Under 3 lags selected by AIC, the statistic is borderline (F = 4.719).

4. Concluding remarks

Tobin's q theory of investment proposes that when the stock-market valuation of existing real capital assets is above its current replacement cost, firms invest more. This paper tests the impact of the higher stock of capital on the labor market by assessing the impact of Tobin's q on the unemployment rate of the post-war U.S. economy. We find a negative response of unemployment to Tobin's q, which is robust to the possibility of unemployment being stationary and q being non-stationary processes. Our results are also robust to different measurements of Tobin's q: the measures by Wright (2004, 2005) and those by Laitner and Stolyarov (2003).

Extensions of this study for further research include performing threshold analysis in order to investigate if, at booms and busts, deviations of Tobin's q from its "normal" level do affect the unemployment rate systematically.

References

Aksoy, Y. and M. León-Ledesma, 2005, Interest rates and output in the long-run (European Central Bank Working Paper Series No. 434, January).

Cummins, J., K. Hassett, and S. Oliner, 2006, Investment behavior, observable expectations, and internal funds, American Economic Review 96 (3), 796-810.

Hayashi, F., 1982, Tobin's marginal q and average q: A neoclassical interpretation, Econometrica 50, 213-224.

Laitner, J. and D. Stolyarov, 2003, Technological change and the stock market, American Economic Review 93 (4), 1240-1267.

Morley, B., 2006, Causality between economic growth and immigration: An ARDL bounds testing approach, Economics Letters 90, 72-76.

Pesaran, M. H., Y. Shin and R. Smith, 2001, Bounds testing approach to the analysis of level relationships, Journal of Applied Econometrics 16, 289-326.

Ricardo, D., 1821 [1970], On the principles of political economy and taxation (Cambridge University Press, Cambridge).

Samuelson, P. A., 1988, Mathematical vindication of Ricardo on machinery, Journal of Political Economy 96, 274-282.

Summers, L., 1981, Taxation and corporate investment: A q-theory approach, Brookings Papers on Economic Activity 1, 67-127.

Tobin, J., 1969, A general equilibrium approach to monetary theory, Journal of Money, Credit and Banking 1, 15-29.

Tobin, J., 1998, Money, credit and capital (McGraw-Hill, New York).

Wright, S., 2004, Measures of stock market value and returns for the U.S. Nonfinancial corporate sector, 1900-2002, Review of Income and Wealth 50 (4), 561-584.

Wright, S., 2005, Technological change and the stock market: A comment (Working Paper Birkbeck College).

Figure 1. The civilian unemployment rate (%) of the U.S.

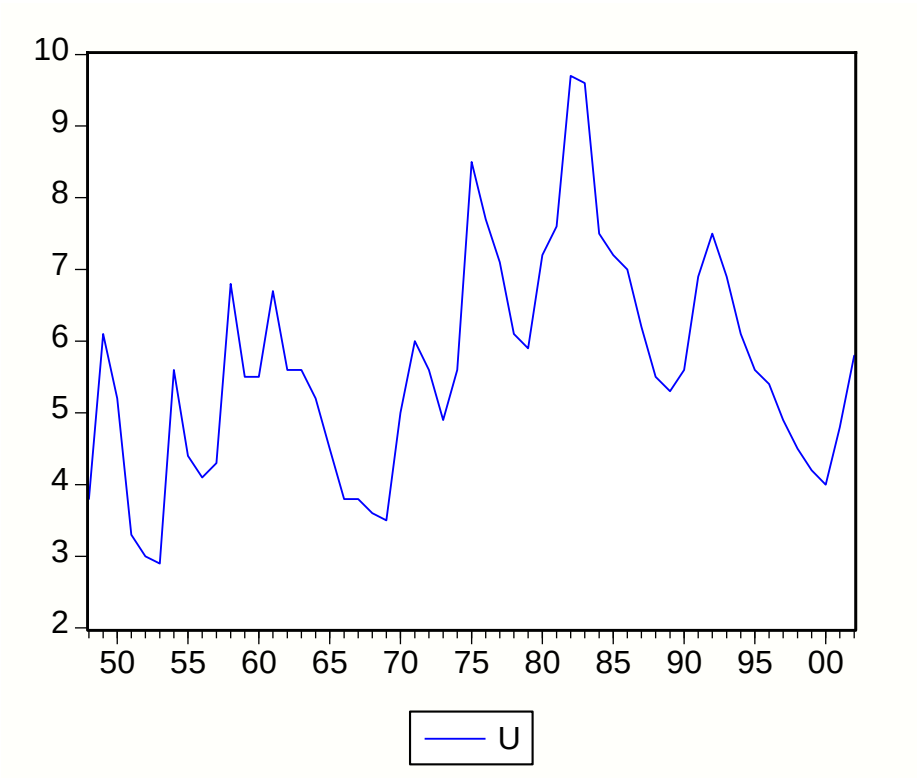

Figure 2. Tobin's *q* for the U.S. calculated by Wright (2004, 2005)

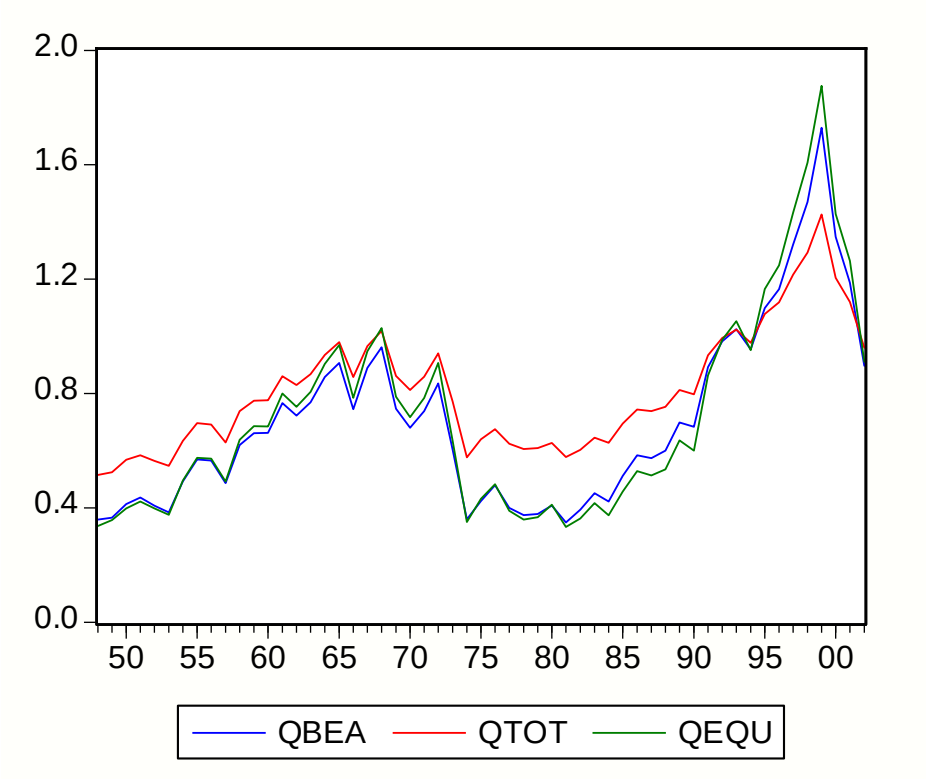

Table 1. Descriptive Statistics: Annual Data.

Series	Mean	Maximum and Minimum	Std. Dev.	Skewness	Kurtosis	JB
qbea	0.706	1.729 0.349	0.315	1.113	3.959	13.466*** [0.001]
qls	1.208	2.290 0.850	0.322	1.569	5.482	32.004*** [0.000]
u	5.640	9.700 2.900	1.526	0.489	3.144	2.244 [0.326]

Notes: JB is the Jarque Bera normality test, in which *** rejects the null of normality. N = 55 for the qbea sample (1948-2002) and N = 48 for the qls sample (1953-2000).

Table 2. Bounds Test Analysis of Long-Run Relationships.

$$\Delta u_t = \alpha_0 + \alpha_1 t + \varphi u_{t-1} + \Psi qbea_{t-1} + \sum_{j=1}^{p-1} \beta_{uj} \Delta u_{t-j} + \sum_{j=1,}^{q-1} \beta_{qj} \Delta qbea_{t-j} + \omega \Delta qbea_t + \varepsilon_t \qquad (1)$$

	Lag-Length	Selected Criterion	F-III $\varphi = \Psi = 0$ Without t	t-III t-ratio on φ Without t	Selected Criterion	F-IV $\alpha = \varphi = \Psi = 0$ With t	t-IV t-ratio on φ With t
qbea → u	1	SIC	3.391	-2.564	SIC	**6.083**	**-4.236**
	2		2.713	-2.310		**4.702**	**-3.739**
	3	AIC	3.452	-2.484	AIC	**4.719**	**-3.590**
	4		2.443	-2.158		3.653	-3.208
u → qbea	1	AIC, SIC	1.694	-1.451	AIC, SIC	1.216	-1.277
	2		1.996	-1.431		1.317	-0.947
	3		1.869	-1.039		1.231	-0.423
	4		3.561	-1.978		2.326	-0.967
5% Critical Bounds	I (0)		4.94	-2.86		4.68	-3.41
	I (1)		5.73	-3.22		5.15	-3.69

Notes: The table contains F and t-tests for the existence of long-run relationships between the unemployment rate and Tobin's *q*, following Pesaran et al. (2001). **The null hypothesis is that there is no long-run relationship.** If the values fall outside the critical value bounds, a conclusive inference can be drawn. Case III involves intercepts and no trends, while case IV handles intercepts and trends.

Table 3. Long-Run Coefficients and Diagnostics of (1).

Coefficients	1 LAG	2 LAGS	3 LAGS	4 LAGS
α_1	0.040***	0.040***	0.038**	0.040**
(time trend)	(0.013)	(0.014)	(0.015)	(0.017)
φ	-0.506***	-0.537***	-0.567***	-0.608***
(lagged u)	(0.119)	(0.144)	(0.158)	(0.189)
Ψ	-1.815***	-1.845***	-2.267***	-2.262**
(lagged *q*)	(0.649)	(0.727)	(0.761)	(0.897)
DW	1.967	2.015	2.020	2.008
Adj. R^2	0.415	0.405	0.435	0.410
AIC	2.526	2.582	**2.515**	2.606
SIC	**2.786**	2.920	2.932	3.103
LM test	0.00	0.00	0.00	0.00
	[1.00]	[1.00]	[1.00]	[1.00]
JB test	2.558	1.650	0.873	0.830
	[0.278]	[0.438]	[0.646]	[0.660]
CUSUM	Very Stable [no touch on bands]	Unstable [touch lower band 1972-81; 1989-91]	Stable [touch lower band in 1979]	Unstable [touch lower band 1973-79]

Notes: Standard errors are in parenthesis below the coefficients. For diagnostics, the p-values are reported in parenthesis. In bold are the selected lag-lengths from Table 2.