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Competition and performance: The different roles of capital and labor

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Abstract

Neoclassical economists argue that competition promotes efficiency, but Schumpeter argues that it is monopoly rents that help entrepreneurs to invest in R&D. We investigate the overall effect of competition on total factor productivity growth (TFP) growth. We use rent, defined as the factor reward above its perfectly competitive value, as a negative measure of competition. Our main finding is that performance is positively associated with rents on capital but not with rents on labor. Neoclassical economists and Schumpeter may both be right, but the mechanisms differ.

JEL classification: L16; O41; C67

Keywords: Competition; Rent; TFP; Schumpeter hypothesis

1. Introduction

Is competition good for performance? Yes, say neoclassical economists, arguing that it eliminates slack and hence promotes static efficiency. No, say Schumpeter and others, pointing out that monopoly rents induce entrepreneurs to invest in R&D and thus promote dynamic efficiency. The mechanisms alluded to are quite different, and the overall effect of competition becomes an empirical issue. Nickell (1996) finds some support for the view that competition improves performance, but the evidence is not overwhelming. Aghion et al. (2001, 2002) and Boone (2001)

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argue that the relationship between competition and innovation is non-monotonic. Griffith (2001) finds that product market competition improves performance in principal-agent type firms. We will review the argument in some detail and then pitch our approach.

If a market is more competitive, the stakes of sweeping it by winning an innovation contest are greater, as the scope is wider. On a product-by-product basis, however, margins are lower in a more competitive market. Aghion et al. (2001) combine the two countervailing effects in a single model, where industries are duopolies engaged in price (Bertrand) competition. 'Competition' is measured by the elasticity of substitution between the duopolists' products. A higher degree of substitutability boosts the reward to an innovation winner among leveled firms (the neoclassical effect), but reduces the (marginal) reward to non-leveled firms (the Schumpeterian effect). A level field will become less leveled and the new equilibrium is less congenial for innovation; followers face low rents to gain when demand is more elastic, while leaders do not distance themselves further as technological knowledge is assumed to spill over anyway after a single period. Industries become less leveled and the rent dissipation effect overtakes the contest effect. Competition and innovation have an inverted U relationship as a result. In a Hotelling-style example of three vendors Boone finds a U relationship and notes that "basically anything can happen," but Aghion et al. (2002) find empirical support for the inverted U relationship between competition and innovation.

Since Aghion et al. (2001, 2002) measure competition by means of the elasticity of substitution, both the neoclassical and the Schumpeterian effects are channelled through the product markets. This is also the market studied by Griffith, who suggests, however, that agency costs play a role in the scope for performance. We want to analyze the role of factor markets. Do neoclassical economists not argue that competition is good because it keeps managers sharp? And does Schumpeter not argue that monopoly profits are good because they fund R&D? Labor and capital may play conflicting roles in terms of the relationship between competition and performance. This conflict may explain why there is no simple relationship between the two.

Rather than relating rents to elasticities of demand in a neoclassical model of price competition, we decompose rents into factor components in a classical input–output framework and investigate whether the opposing effects of competition operate through different markets. A natural thought seems to be that competition in the labor market may be good, but competition in the capital market may be bad, both in terms of performance. In other words, neoclassical and Schumpeterian economists may both be right, but rather than combining the opposing effects in some non-linear relationship, we point to different factor markets. The potential policy conclusions would be vastly different. The aforementioned literature may suggest an optimal level of product market competition at best. We say at best, because competition is modeled as a shift in consumers' preferences (more substitutability) and firms are assumed to (Bertrand) price compete throughout. In this paper, however, departures from competition are modeled directly as rents and factor markets are targeted.

What do we mean by competition and performance? The measurement of performance is relatively straightforward. Solow (1957) has demonstrated for perfectly competitive economies that the shift of the production possibility frontier, which is the ultimate determinant of the standard of living, is measured by total factor productivity growth (TFP). TFP is also the relevant measure for the standard of living in non- or less competitive economies, where it measures not only the shift of the frontier, but also the change in efficiency (Nishimizu and Page, 1982). In short, we let performance be measured by TFP.

The measurement of competition is trickier. The industrial organization literature provides a number of indices. Perhaps concentration indices are the most popular ones, but we will not employ them. We believe that industries with a low number of firms may well be competitive. In the tradition of Lerner (1934) we measure market power more directly by the extent that price has been raised over cost (i.e. by rent). Indeed, Nickell finds that rent is the most important determinant in the assessment of the influence of competition on performance, but rent is hard to measure. Nickell takes the difference between the rates of return on company capital and treasury bonds and admits this merely measures capital rent, and even as such is only a rough proxy; neoclassical economists point out that competition stamps out labor rent.

In the spirit of Nickell we take rent as the (negative) measure of competition and define it by the difference between actual and perfectly competitive rewards. Actual rewards are given by value-added and perfectly competitive rewards by factor costs at shadow prices. To determine the latter we need a general equilibrium model, which may have been the main obstacle in assessing the role of competition in the performance of an economy. We do so by analyzing Canadian input–output data over the period 1962–1991. Rent and TFP are determined at a level of aggregation that is more macro- than micro-economic.

Section 2 presents the model we employ to determine competitive valuations. Then, in Section 3, we define rent and impute it to capital and labor. Section 4 investigates the relationship between competition and performance (as measured by rent and TFP, respectively).

2. The productivity model

Both competition and performance are related to productivity. For performance the connection to productivity is straightforward, as it is measured by TFP, the growth of (total factor) productivity. The connection between competition and rent is slightly more indirect. Competition is (negatively) measured by rent. Rent is the difference between actual and perfectly competitive rewards where the latter are essentially marginal productivities.

The standard approach to productivity is neoclassical TFP analysis, where output and input components are combined into indices using value shares as weights. The acceptance of value shares at face value is equivalent to taking factor rewards for granted, and this procedure has been justified for perfectly competitive economies (Solow, 1957; Jorgenson and Griliches, 1967). We, however, are interested in the difference between observed and competitive rewards and, therefore, cannot apply the standard procedure, but must derive productivities from the real input and output data of the economy.

We follow Nishimizu and Page in letting total factor productivity growth be the composition of a shift of the best-practice frontier (true technological progress) and a change in technical efficiency, and in using linear programming techniques to identify the frontier and the resulting level of efficiency. Nishimizu and Page use sectoral panel data to estimate a time-shifting translog production frontier for every sector and sectoral levels of technical efficiency in each period, but ignore the input balance constraints. We estimate instead a general equilibrium model with different sectoral levels of activity in each period and an overall level of technical efficiency for the whole economy in each period.

Our model is input–output in spirit, but we admit different numbers of industries and of commodities, as in activity analysis. Industries transform factor inputs and intermediate inputs into outputs, and the net output commodity vector feeds domestic final demand and net exports. The marginal productivities of the factor inputs are the shadow prices associated with the factor constraints of the program that maximizes welfare. Now if we assume that producers use Leontief technologies and end users of the commodities have Leontief preferences, then the formulas governing these shadow prices are perfectly consistent with neoclassical growth accounting and, moreover, capture the efficiency change effect of frontier analysis; see ten Raa and Mohnen (2002).

The model maximizes the level of domestic final demand, given its commodity proportions and subject to material balances, factor constraints, and balance of payments:

$$\begin{aligned} &\max_{s,c,g} e^{\mathrm{T}} fc \text{ subject to} \\ &(V^{\mathrm{T}} - U)s \geq fc + Jg =: F \\ &Ks \leq M \\ &Ls \leq N \\ &-\pi g \leq -\pi g' =: D \\ &s \geq 0. \end{aligned} \tag{1}$$

The variables (s, c, g) and parameters (all other) are the following [with dimensions in brackets]:

s	activity vector [# of industries]
c	level of domestic final demand [scalar]
g	vector of net exports [# of tradable commodities]
e	unit vector with all components equal to one
T	transposition symbol
f	domestic final demand [# of commodities]
V	make table [# of industries by # of commodities]
U	use table [# of commodities by # of industries]
J	0–1 matrix placing tradable [# of commodities by # of tradables]
F	potential final demand [# of commodities]
K	capital stock matrix [# of capital types by # of industries]
M	capital endowment [# of capital types]
L	labor employment row vector [# of industries]
N	labor force [scalar]
π	U.S. relative price row vector [# of tradable]
g^t	vector of net exports observed at time t [# of tradable]
D	observed trade deficit [scalar].

In (1), the observed allocation corresponds to $s = e$ and $c = 1$. This is feasible. The optimal value of expansion factor c will be greater than one. It measures the ratio of potential to actual domestic absorption. Domestic absorption is GDP except net exports; it is also called domestic GDP. We denote the shadow prices associated with the constraints of program (1) by p (a row vector of commodity prices), r (a row vector of capital productivities), w (a scalar for labor productivity), ε (a scalar for the purchasing power parity), and σ (a row vector of slacks for the sectors). Then the dual program reads

$$\begin{aligned} &\min_{p,r,w,\sigma \geq 0} rM + wN + \varepsilon D \text{ subject to} \\ &p(V^{\mathrm{T}} - U) = rK + wL - \sigma \\ &pf = e^{\mathrm{T}} f \\ &pJ = \varepsilon\pi. \end{aligned} \tag{2}$$

The first dual constraint equates value added to factor costs for active industries (which have zero slack according to the theory of linear programming), all at shadow prices. The second dual constraint normalizes the level of commodity prices by the multiplicative constant we entered in the objective function of (1). The third dual constraint aligns the prices of the tradable commodities with the terms-of-trade.

The primal (1) and dual (2) programs have equal value by the main theorem of linear programming. In view of the price normalization constraint of (2) the identity reads

$$pfc = rM + wN + \varepsilon D \tag{3}$$

The *level* of total factor productivity is given by the ratio of actual output to optimally weighted factor input, $e^{\mathrm{T}} f/(rM + wN + \varepsilon D)$. According to Eq. (3) the level of total factor productivity is $1/c$, which is essentially Debreu's coefficient of resource allocation (ten Raa, 2003). *Total factor productivity growth* is the rate of growth of the level of total factor productivity at *fixed* price weights[1]:

$$TFP = \frac{p\dot{f}}{pf} - \frac{rM + wN + \varepsilon\dot{D}}{rM + wN + \varepsilon D}. \tag{4}$$

Total factor productivity growth has been shown to be the sum of the Solow residual,

$$SR = \frac{[p\dot{F} - r(K\dot{s}) - w(L\dot{s})]}{rM + wN + \varepsilon D}, \tag{5}$$

the terms-of-trade effect,

$$TT = \frac{\varepsilon\dot{\pi}g}{rM + wN + \varepsilon D}, \tag{6}$$

and the efficiency change,

$$EC = -\frac{\dot{c}}{c}, \tag{7}$$

in ten Raa and Mohnen. The Solow residual is a Domar weighted average of industry Solow residuals (Mohnen and ten Raa, 2000):

$$SRi = \frac{p(V^{\mathrm{T}} - \dot{U})_{.i} - r\dot{K}_i - w\dot{L}_i}{pV_i}. \tag{8}$$

with weights

$$\frac{pV_i \cdot s_i}{pfc}. \tag{9}$$

The industry Solow residuals measure the dynamic performance of the economy. The static performance is measured by the efficiency change. The latter, see formula (8), measures the growth rate of the actual/potential GDP ratio because c measures the ratio of potential to actual domestic GDP. Here, efficiency change is driven by reallocations of the factor inputs, capital and labor, between industries. It could be imputed to the industries following ten Raa (2003), but these efficiency changes would still measure inter-industry allocative gains rather than intra-industry catching up with best practices. Input–output analysis implicitly identifies technical coefficients with observed input–output proportions. sectoral productivity growth rates, see (8), capture technical change, intra-firm efficiency changes and inter-firm allocative efficiency changes

[1] *Warning*: We use *TFP* for TFP growth. No symbol is needed for the level of TFP. As usual, a dot denotes differentiation with respect to time.

(ten Raa, 2005). It would be interesting to make this further decomposition, but that requires access to and use of the establishment data underlying the use and make tables.

3. Rent

In a broad sense, rent comprises all payments made to factor inputs for the provision of their services. The owner of a building collects rent from the businesses that use the space, and a worker receives compensation for the labor provided. This broad concept of rent includes not only the opportunity costs of the services but also the bonuses that reflect distortions such as market power. The narrow concept of rent, however, is limited to these bonuses and, therefore, consists of the excess payments over and above the opportunity cost. It is the latter concept of rent that we use to measure departures from competition.

The first dual constraint of (2) is the value relationship between value-added and factor costs when prices are competitive. It has its counterpart for observed prices, which we denote by $p^{\rm o}$, $r^{\rm o}$, and $w^{\rm o}$ for commodities, capital, and labor, respectively, where the superscript indicates 'observed.' Thus,

$$p^{\rm o}(V^{\rm T} - U) = r^{\rm o}K + w^{\rm o}L + \sigma^{\rm o}. \tag{10}$$

Here $\sigma^{\rm o}$ is defined residually and represents profits.[2]

We define *rent* as the difference between observed value-added, given by row vector $p^{\rm o}(V^{\rm T} - U)$, and competitive value-added, given by row vector $v = p(V^{\rm T} - U)$. The row vector of differences defines rent by sector. We can impute rent (in each sector) to the factor suppliers. Subtracting the first dual equation in program (2) from Eq. (10) we obtain

$$Rent = (r^{\rm o} - r)K + (w^{\rm o} - w)L + (\sigma^{\rm o} + \sigma). \tag{11}$$

In words, rent is the sum of capitalists' rent, workers' rent, and excess profits. Often capitalists' rent and excess profits are pooled to define *K-rent*, $(r^{\rm o} - r)K + (\sigma^{\rm o} + \sigma)$. Similarly denoting workers' rent $(w^{\rm o} - w)L$ by *L-rent*, Eq. (11) is consolidated as follows:

$$Rent = K\text{-}rent + L\text{-}rent. \tag{12}$$

Notice that each term in Eq. (12) is a row vector of industry rents. The consolidation of profits into capital rent is apt for economies where profits accrue to shareholders rather than workers (i.e. capitalism). All the rent terms represent excess payments, over and above competitive values, so that rent is a negative measure for competitiveness. This is in the spirit of Nickell, who captures capital rent by putting r = treasury bills rates and $\sigma = 0$, and who misses labor rent. We fill the gaps by letting our general equilibrium model determine the shadow prices.

Although we are able to dissociate capital from labor rents, we admit that we face some aggregation problems. There are more than three types of capital: often software, hardware, telecommunication equipment and inventories are measured as separate pieces of the aggregate capital stock, and the separation of R&D from value added is presently under discussion in

[2] Given that the make matrix V is in producer prices and the use matrix U (and the final demand vector F) is in consumer prices, there is a discrepancy due to various types of margins. The Canadian input–output tables contain a separate table of seven types of margins. We have assimilated the margins to final demand, which is computed residually from the U, V and net trade (g) data. The margins are most likely included in our residual measure of observed capital rents, obtained by subtracting observed labor payments from observed value added.

statistical offices. There is certainly more than one type of labor. Actually, data on labor by type of occupation exist for Canada, but not for the whole period that we are analyzing.[3] Therefore, we have not separated out labor into different types. Given the different compositions by type of labor and capital across industries, our assumption of uniform competitive factor payments across sectors is certainly debatable, and we will do this in the next section.

4. Competition and performance

The standard approach to measuring the impact of competition on performance is to regress the Solow residual (representing performance) on rent (representing the departure from competition):

$$SR_{it} = \alpha + \beta Rentit - 1 + \varepsilon_{it}, \quad \varepsilon_{it} = \mu_i + \lambda_t + \nu_{it}; \quad i = 1, \ldots, 45, \quad t = 1963, \ldots, 1991. \tag{13}$$

A positive role of competition would be signaled by a negative value of β. Coefficient α represents technological progress. The *data* underlying our panel of growth rates for 45 Canadian sectors and 29 time periods are described in Appendix in Supplementary Material. In order to control for industry specific and time-specific effects on productivity, we model a two-way error component model: μ_i represents the sector effect and is distributed i.i.d. with mean zero and standard deviation σ_μ, λ_t represents the time effect, distributed i.i.d. with mean zero and standard deviation σ_t, and ν_{it} is the idiosyncratic effect, distributed i.i.d. with mean zero and standard deviation σ_ν. A generalized least-squares estimation produces consistent estimates if there is no correlation between the composite error term and the rent. If $\sigma_\mu = \sigma_\nu = 0$, we have a fixed sectoral and time effects model. In Eq. (13) we have instrumented rent by its one-period lagged value to avoid a possible simultaneity bias.[4]

We have first tested whether we cannot pool the data. The Chow test rejects pooling of different industries (a test statistic of 1.56 above the tabulated value of a $\chi^2_{44,1303}$). When, however, we allow for different β's over time or over time and sectors, we cannot reject homogeneity ($0.50 < \chi^2_{28,1303}$ and $1.16 < \chi^2_{72,1303}$, respectively). Next, we have estimated Eq. (13) using sector, time and sector/time dummies (i.e. exploiting, respectively, deviations from the industry means, from the year means, and the double deviations from time and industry means). We have estimated the model once using total rent, and once with rent split into labor and capital components. Since labor and capital rents may influence performance in different ways, it is interesting to investigate their separate effects. The results are tabulated in Table 1. In all cases we reject the absence of sector-specific or time-specific fixed effects. We see that the effect of total rents on TFP is always positive, although in the most preferred specification (with time and industry dummies) it is significant only at 6.7 percent level of confidence. Splitting rents, we find that the labor components are generally insignificant and that the capital components consistently have positive effects, significant at the 5 percent level as soon as we control for time effects.

[3] Canadian data on skill levels, based on the national occupational classification (NOC) or the standard occupational classification exist continuously only from 1980 onwards. Gera et al. (2001) have used those data and constructed two sets of four skill levels (based on occupations, however, and not on qualifications) using the NOC classification and a skill classification proposed by Baumol and Wolff (1989) and updated by Wolff (2006). We have preferred to work with a longer dataset spanning 30 years without distinguishing labor by type of skills.

[4] It should be mentioned that the causality between rent and TFP may also flow the other way. Rents may be the result of ex-post successful innovations. By inverting the lag structure one could try to identify the direction of causality.

Table 1
Within regression of TFP on rents (percentage points increases per billion Canadian dollars, *p*-values in parentheses)

Regressors	Standard: total rent				Separate labor and capital rents			
	1	2	3	4	5	6	7	8
Total rent	0.023 (0.154)	0.037 (0.166)	0.026 (0.091)	0.047 (0.067)	–	–	–	–
Labor rent	–	–	–	–	0.0161 (0.406)	0.059 (0.065)	−0.051 (0.786)	−0.003 (0.920)
Capital rent	–	–	–	–	0.028 (0.114)	0.024 (0.399)	0.052 (0.004)	0.084 (0.004)
Dummies	None	Industry	Time	Both	None	Industry	Time	Both
SSR	2.02191	1.79794	1.84367	1.61900	2.02119	1.79566	1.83093	1.61009
d.f.	1303	1259	1275	1231	1302	1258	1274	1230
F-test		3.28^{**}	4.10^{**}	3.60^{**}		3.30^{**}	4.38^{**}	3.67^{**}

The dependent variable is the industry Solow residual; SSR is the sum of squared residuals; d.f. is degrees of freedom; the *F*-test tests the joint significance of the dummy coefficients; **significance at the 5 percent level.

Table 2
One-way and two-way random effects regression of TFP on rents (percentage points increases per billion Canadian dollars, *p*-values in parentheses, except where indicated)

	One-way	One-way	Two-way
Labor rent	0.037 (0.152)	0.000 (0.998)	0.007 (0.795)
Capital rent	0.025 (0.288)	0.058 (0.009)	0.057 (0.016)
σ_μ	0.0112 (0.0017)*	–	0.0111 (0.0016)*
σ_t	–	0.0108 (0.0018)*	0.0111 (0.0018)*
Hausman test of exogeneity of rents	2.64 (0.267)	7.83 (0.020)	4.09 (0.129)

*Standard errors in parentheses. The dependent variable is the industry Solow residual.

The interesting result is thus that rents in the hands of capital but not rents in the hands of labor yield higher TFP. The estimates indicate the need to control for time-specific effects (although the test of pooling reveals no heterogeneity over time). Remember that the sectoral TFP figures are obtained jointly by the resolution of pairs of linear programs. By the general equilibrium property year-specific shocks are transmitted to all sectors. Thus, we have good reasons to believe that time effects are important indeed.

In Table 2 we estimate a random effects specification of heterogeneity for the model with both types of factor rents. The sector and year error components have standard deviations that are significantly different from zero. According to the Hausman test, there is no correlation between the factor rents and the error terms, except when sector effects are not controlled for. We therefore prefer the random effects estimates, since under that hypothesis they are more efficient. Labor rent is never significant. Capital rent, however, boosts TFP. A billion dollar increase in capital rents, which corresponds on average to roughly 30 percent of the total capital rents per sector, increases sectoral TFP growth by 0.06 percent. The magnitude of the lack of competition effect is not tremendous, but the sign agrees with the Schumpeterian perspective.

The conflict between neoclassical and Schumpeterian economists on the role of competition has never been resolved by the evidence. Our disaggregation of rent into capital and labor components throws some dim light on the issue. Both Schumpeter and the neoclassical economists may be right, but their mechanisms are channeled through different markets, namely the capital and labor markets, respectively. In hindsight this should not come as a surprise. Schumpeter's argument, that departures from competition may yield positive contributions to dynamic efficiency, was built on the role of R&D, particularly the way it is financed. The neoclassical argument, that competition is good, has been built on the insight that it eliminates slack, particularly managerial laziness. Upon closer inspection, the arguments point at different factor markets and may both apply. We obtain evidence in favor of a Schumpeterian effect that operates through the capital market, but no evidence of a neoclassical effect that would operate through the labor market. At this junction we wish to recall that our data set does not allow for differences in labor quality. A referee's hunch is that sectors with a preponderance of high quality labor would exhibit higher TFP. Because labor 'rent' is high in these sectors when not corrected for quality, correcting for quality will lead to a more negative coefficient of labor rent on TFP, resurrecting the neoclassical effect.[5]

[5] The issue of disentangling capital rents from higher return requirements is also difficult. For example, in cyclical sensitive sectors, one would expect a higher return to capital, and not call this rent. Also, in sectors where large intangible investments are made (media, pharma), high rents may just reflect measurement error in capital services. Luckily, any systematic, non-time varying effect of these will be soaked up by the fixed effects.

Table 3
Effects of net R&D expenditures on rents

	Sector heterogeneity		Time heterogeneity		Sector and time heterogeneities	
	Fixed effects	Random effects	Fixed effects	Random effects	Fixed effects	Random effects
Labor rent	−0.319 (0.568)	−0.279 (0.614)	1.190 (0.049)	0.994 (0.096)	0.238 (0.671)	0.148 (0.787)
Capital rent	1.336 (0.008)	1.308 (0.009)	−0.067 (0.907)	0.182 (0.747)	0.641 (0.211)	0.764 (0.125)
σ_μ	–	104.177 (11.141)*	–	–	–	103.72 (11.08)*
σ_t	–	–	–	17.42 (4.87)*	–	22.42 (3.54)*
Hausman test		1.030 (0.598)		7.46 (0.024)+		2.18 (0.340)+

Fixed and random effects models, with sector and/or time as sources of heterogeneity (*p*-values in parentheses, except where otherwise indicated). *Notes*: the dependent variable is the industry Solow residual. *Standard errors in parentheses. +The Hausman test of exogeneity of rents is not very reliable as it is based on a non-positive definite difference in the variance–covariance matrices of the respective estimates.

In Table 3 we double-check the hypothesis of a Schumpeterian effect from capital rent on productivity, knowing that there is a large consensus that R&D earns a positive rate of return and hence has a positive effect on TFP. We regress by ordinary least squares the pooled data of R&D stock on capital rent and labor rent, again lagged by one period. We present the estimates of both the fixed effects and the random effects models, with one and two sources of heterogeneity. The Hausman test is only reliable for the sector heterogeneity, where it accepts the exogeneity of the regressors with respect to the error terms. In any case, the fixed and random effects estimates tell the same story. When we control for the greatest source of heterogeneity (sectoral effects), the capital rent is positively correlated with the R&D expenditures, as hypothesized by Schumpeter, but not with labor rent. When we control for time effects, surprisingly it is labor rent that is positively correlated with R&D expenditures, whereas capital rent is not significant. The deviations over time of R&D expenditures with respect to industry means are positively correlated with deviations in capital rents from industry means. The sectoral deviations with respect to yearly means across all sectors seem to be correlated with the same kind of deviations in labor rents. The story could still be consistent with a neoclassical view, in the sense that excess labor rent stimulates attempts to reduce cost through process R&D. (This interpretation would require additional verification. We do not at this stage have R&D split into process and product R&D.) If we control for both sources of heterogeneity, no factor rent is significant, although at the margin (if we accept a 12.5 percent level of confidence) we would accept the Schumpeter hypothesis.

5. Conclusion

We have investigated the influence of competition on performance. Performance is measured by Solow residuals derived from a general equilibrium model that maximizes the standard of living. The factor rewards are shadow prices, which are not necessarily equal to the observed rewards. In fact, the difference is rent, which we take as the (negative) measure of competition.

The weak evidence we have found can be summarized as follows. Total rent exerts a positive influence on productivity performance, and it is significant at the 7 percent level, even if we control for business cycle and technological opportunity effects by using time and sector dummies. Capital rents dominate the total effect. When capital and labor rents enter the equation separately, labor rents become insignificant, but capital rents continue to have a strong positive sign. Schumpeter and the neoclassical economists may both be right, but their mechanisms are channeled through different factor markets, namely the capital and labor markets, respectively. Indeed, the use of rent as a source of funding for R&D applies to capital, and the argument that rent yields slack pertains to labor. The Schumpeter hypothesis is also backed by R&D regressions on capital rent.

If capital rent is positive for performance, the policy issue emerges of how to promote technological progress without skewing the income distribution too much. An intelligent policy suggestion would be to reallocate the Schumpeterian advantages of capital rents to workers by providing them with stock options. This practice is spreading in the Western world and may indeed reconcile the different roles of capital and labor competition in performance.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jebo.2005.12.007.

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