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A Methodological Note on Measuring the Functional Efficiency of Capital Markets

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Abstract
We apply the accelerator principle to measure the functional efficiency of capital markets. We estimate the elasticity of capital with respect to output using a panel of firms across 44 countries, and compare the results with existing approaches. Furthermore, we correlate our measure with corporate governance institutions.

JEL classifications: C00, G32, P00

Keywords: Allocation of capital, accelerator principle, functional efficiency

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Introduction

The allocation of capital and relevant institutions are critical determinants of economic performance, but cross-country research is complicated by the significance of economic development. We derive a method where this is not the case.

Econometric Model

To estimate the functional efficiency of capital allocation[1], Wurgler (2000) estimates industry elasticity of *investments* with respect to industry value-added. Mueller and Reardon (1993) do this by estimating Marginal *q*, which measures the return on investments relative to opportunity cost (see Gugler et al., 2004). The use of Marginal *q* is consistent with conventional investment theory, but Wurgler's measure is not[2].

To measure capital allocation at the *firm* level, we modify Wurgler (2000) to make the method consistent with the accelerator principle and investment theory. To do this, we measure elasticity of *capital* with respect to output, measured as *sales.* Assuming constant prices, changes in sales will be proportional to changes in output. C*eteris paribus*, higher elasticity of capital with respect to sales means quicker response to changes in expected returns and therefore, more efficient capital allocation.

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[1] Tobin (1984).

[2] Wurgler (2000) estimates elasticity of investments with respect to value added, η, as: $\ln\left(\frac{I_t}{I_{t-1}}\right) = \alpha + \eta \ln\left(\frac{V_t}{V_{t-1}}\right) + \varepsilon$, where *I* is industry investments (gross fixed capital formulation) and *V* is value added. Presumably he does this for empirical reasons, since he uses aggregated industry data. However, one may still expect a high correlation between η and λ^*. For elasticity of capital to equal elasticity of investments, it is necessary that $\Delta K_t^* = \Delta I_t$. This happens only if $I_{t-1} = \delta K_{t-1}$ which implies that $K_{t-1}^* = K_{t-1}$. Mueller and Reardon (1993) estimate q_m as: $\frac{M_t - M_{t-1}}{M_{t-1}} = -\delta + q_m \frac{I_t}{M_{t-1}} + \varepsilon$, where M_t and I_t is market value and investments respectively.

The accelerator model of investments captures time structure and responses to changes in expectations. Several proxies can be used as accelerators[3]. We choose sales because of inconsistent measurements of value-added across industries and countries[4].

In accelerator models, the desired level of capital, K_t^* is determined by output, Y_t:

$$K_t^* = kY_t \tag{1}$$

where k is the capital coefficient (capital-output ratio)[5]. We assume K_t^* to equal to actual capital, K_t. This means net investments, I_t and (K_t - K_{t-1}), are proportional to changes in desired stock of capital, $K_t^* - K_{t-1}^*$. Net investments, NI_t, is expressed:

$$NI_t = \lambda(Y_t - Y_{t-1}) \tag{2}$$

Net investments are proportional to an accelerator λ. If $K_t^* = K_t$ then $\lambda = k$. This equilibrium assumption is typically unfulfilled, but not relevant here[6]. For gross investments, we add replacement investments which are proportional to old capital, δK_{t-1}:

$$I_t = \delta K_{t-1} + \lambda \Delta Y_t \tag{3}$$

We divide both sides with K_{t-1}:

$$\frac{I_t}{K_{t-1}} = \delta + \lambda \frac{\Delta Y_t}{K_{t-1}} \tag{4}$$

[3] Tinbergen (1938, 1939), Jorgenson and Siebert (1968), Kuh (1963) and Jorgenson (1971).
[4] Value-added is calculated in two ways: 1) Sales – costs for intermediary goods, 2) Profit + cost of labor. Sales are relatively unproblematic but costs of intermediary goods and labor are counted differently across countries.
[5] Kaldor (1963) argues this ratio is stable over time.
[6] If fulfilled, there would be efficient allocation all the time, with an elasticity of one. See Jorgenson (1971) and Tinbergen (1938).

Since $K_t^* = kY_t$ this is reformulated as:

$$\frac{I_t}{K_{t-1}} = \delta + \lambda^* \frac{\Delta Y_t}{Y_{t-1}} \tag{5}$$

where $\lambda^* = (\lambda/k)$, which is *elasticity of capital* with respect to *output* (sales). This is additionally useful because it achieves a normalization that reduces heteroskedasticity, making equation 4 possible to estimate. Note that if $K_t^* = K_t$ at every point in time, then $\lambda = k$, which means $\lambda^* = 1$.

We estimate for each country:

$$\frac{I_{i,t}}{K_{i,t-1}} = \delta + \alpha_i + \theta_t + \lambda^* \frac{\Delta S_{i,t}}{S_{i,t-1}} + \varepsilon_{i,t} \tag{6}$$

where λ^* is elasticity of investments with respect to sales, *I* is investments made by firm *i* in period *t*, *K* is capital stock in period *t-1* and *S* is sales in period *t*.

Cross-country panel studies are interested in country-specific estimations of capital elasticity, favoring a *fixed effects* model with *firm* and *time effects* (α_i and θ_t).

Data

We use firm-level accounting data from *Standard & Poor's Compustat Global* to measure gross investments:

$$I = \textit{After tax profit} - \textit{dividends} + \textit{depreciation} + \Delta\textit{Equity} + \Delta\textit{Debt} + \textit{R\&D}$$

This adequately reflects actual investments. Using gross investments is more appropriate than net investments because it is not possible to obtain reliable estimates for replacement investments. Although advertising and marketing should arguably be included in investments (Mueller and Reardon, 1993), we exclude them because of inconsistently available across countries. Financial firms are excluded from the sample.

The measure of capital is selected to be consistent across countries. Variables are adjusted to 2000 constant prices with inflation data from International Financial Statistics (IMF). A total of 11984 included firms yield 61292 observations across 44 countries. To minimize the weight of outliers, observations for each country are cut five percent at each end of the distribution. In Table 1, we group countries by legal origin (see La Porta et al., 2003).

We use the following explanatory variables: Property rights (Holmes et al, 1997); Minority shareholder protection (Pagano and Volpin, 2005[7]); Law and order (averaged for 1982-1995, from *International Country Risk Guide*); Ownership concentration (La Porta et al, 1998); Family ownership concentration (La Porta et al, 1999[8]). We add dummies for legal origins (La Porta et al., 2003) classified as English, German, French, Scandinavian and Socialist/Communist. We use standard controls for economic development as logarithm of 1995 GDP and economic growth as average GDP growth between 1980 and 2002[9].

Results

We compare our measure with estimates of marginal *q* by Gugler et al (2004) and find no significant correlation. However, marginal *q* is significantly correlated with ownership concentration, property rights and shareholder protection. The merit of our model is reflected in Table 2. When we regress Wurgler's elasticity estimates on our measure of elasticity, the coefficient is close to one (Table 3). The interesting comparison between

[7] This is an extended version of La Porta et al (1998), also called the LLSV Pagano-Volpin anti-director index. It covers 1993 to 2001; we use the average.
[8] This is measured as control rights, not cash-flow rights. Data for Indonesia, Philippines, Taiwan and Thailand is from Claessens et al (2000).
[9] Data for both is from *World Development Indicators;* data for Taiwan is from La Porta et al. (1997).

Wurgler (2000) and our measure is the correlation with control variables. GDP growth is significant and negatively correlated with both our measure (-0.34) and Wurgler (-0.4). However, current GDP is positively and significantly correlated with Wurgler's measure (0.44) but *not* our measure. This suggests our measure is not sensitive to economic development but is sensitive to economic growth. This makes it robust for cross-country study.

Results for legal origin do not support the legal origins hypothesis (La Porta et al., 1998). We find weak protection of property combined with high ownership concentration, particularly family, appear to hamper capital allocation. Property rights and law and order have a positive and significant correlation (at the 5% level) with elasticity.

There are several explanations for capital elasticity greater than one. First, indivisibilities of production factors may make the production function discontinuous, so output cannot be produced proportionally to capital. Second, "excessive expectations" may affect estimates (Manne, 1945). Third, if I_t or K_t contain measurement errors, this can create scaling effects so estimated elasticity deviates from its true value. However, this is unlikely to be problematic here since variables were chosen for consistent cross-country estimation. This is why we use sales to measure output. Any measurement error will be consistent across all countries, since elasticity is a *relative* measure of efficiency of capital allocation. An interesting next step is to compare firms within a country.

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Table 1 Capital elasticities with respect to Sales, $\hat{\lambda}_j^*$

Country	$\hat{\lambda}_j^*$	t-value	Std. Err.	R^2	No. firms	No. obs.	Period
Australia	0.621	13.7	0.045	0.09	377	2047	1999-2005
Canada	0.849	15.0	0.057	0.14	303	1646	1999-2005
Hong Kong	0.756	8.24	0.092	0.12	101	550	1999-2005
India	0.687	13.6	0.051	0.17	169	912	1999-2005
Ireland	1.464	6.99	0.210	0.26	33	178	1999-2005
Israel	0.609	2.05	0.297	0.06	26	140	1999-2005
Malaysia	0.400	16.4	0.024	0.15	524	2371	1999-2005
New Zealand	0.829	3.02	0.275	0.07	52	234	2000-2005
Pakistan	0.367	3.09	0.119	0.12	26	164	1998-2005
Singapore	0.776	18.9	0.041	0.25	301	1363	2000-2005
South Africa	1.064	6.26	0.170	0.09	114	512	2000-2005
Thailand	0.523	9.91	0.053	0.13	217	1182	1999-2005
United Kingdom	1.276	18.8	0.068	0.09	691	3774	1999-2005
United States	1.160	42.5	0.027	0.16	2137	11642	1999-2005
English legal origin average[a]	***0.884 (0.813)***	***54.7***	***0.016***	***0.11***	***5071***	***26715***	-
Argentina	0.600	7.73	0.078	0.37	21	114	1999-2005
Belgium	1.266	8.05	0.157	0.18	72	400	1999-2005
Brazil	0.551	8.41	0.066	0.15	96	524	1999-2005
Chile	0.431	7.96	0.054	0.20	80	438	1999-2005
Colombia	0.283	1.88	0.151	0.13	10	54	1999-2005
France	1.575	14.8	0.106	0.10	362	1976	1999-2005
Greece	1.034	9.96	0.104	0.27	55	296	1999-2005
Indonesia	0.342	4.92	0.069	0.07	170	764	1999-2005
Italy	0.937	8.14	0.115	0.11	160	738	2000-2005
Mexico	0.715	8.58	0.083	0.31	57	308	1999-2005
The Netherlands	1.595	11.2	0.142	0.15	113	620	1999-2005
Peru	0.675	8.89	0.075	0.44	18	123	1997-2005
The Philippines	0.645	12.8	0.050	0.31	69	373	1999-2005
Portugal	1.219	6.62	0.184	0.30	26	140	1999-2005
Spain	0.942	11.8	0.080	0.25	76	410	1999-2005
Turkey	0.567	2.53	0.224	0.06	29	156	1999-2005
French legal origin average[a]	***1.155 (0.836)***	***27.6***	***0.042***	***0.10***	***1414***	***7434***	-
Austria	1.167	7.47	0.156	0.25	43	248	1999-2005
Germany	1.579	18.7	0.085	0.12	431	2344	1999-2005
Japan	0.603	38.5	0.016	0.24	2860	13230	2000-2005
South Korea	0.817	21.4	0.038	0.35	203	927	2000-2005
Switzerland	0.946	12.6	0.075	0.21	142	782	1999-2005
Taiwan	0.725	16.0	0.045	0.26	180	972	1999-2005
German legal origin average[a]	***1.098 (0.973)***	***48.6***	***0.023***	***0.13***	***3859***	***18503***	-
Denmark	0.977	7.08	0.138	0.12	86	470	1999-2005
Finland	1.619	9.21	0.176	0.20	84	454	1999-2005
Norway	2.340	5.38	0.435	0.07	89	404	2000-2005
Sweden	1.177	6.91	0.170	0.05	173	961	1999-2005
Scandinavian legal origin average[a]	***1.279 (1.528)***	***11.2***	***0.115***	***0.06***	***432***	***2289***	-
China	0.482	30.5	0.016	0.21	1130	6108	1999-2005
Hungary	0.730	4.41	0.165	0.29	11	60	1999-2005
Poland	1.331	5.88	0.227	0.29	19	119	1998-2005
Russia	0.434	3.42	0.127	0.36	12	64	1999-2005
Socialist/communist legal origin average[a]	***0.492 (0.744)***	***31.2***	***0.016***	***0.20***	***1172***	***6351***	-
Average / total[a]	***0.914 (0.902)***	***77.5***	***0.012***	***0.10***	***11948***	***61292***	-

[a] These are weighted averages. Note that this gives different weights to countries. Simple averages $\hat{\lambda}_j^*$ are in brackets.

Table 2 Correlation Matrix

	$\hat{\lambda}_j^*$	Ownership (mean)	Ownership (median)	Family ownership (10%)	Family ownership (20%)	Property rights	shareholder protection	Law and order	Log GDP	GDP growth	Marginal q, q_m
$\hat{\lambda}_j^*$	1										
Ownership (mean)	- 0.27	1									
Ownership (median)	- 0.32	0.96	1								
Family ownership (10%)	- 0.48*	0.53*	0.59*	1							
Family ownership (20%)	- 0.49*	0.54*	0.57*	0.95*	1						
Property rights	0.43*	- 0.51*	- 0.55	- 0.60*	- 0.61*	1					
shareholder protection	- 0.20	- 0.21	- 0.20	- 0.30	- 0.29	- 0.10	1				
Law and order	0.61*	- 0.44*	- 0.46*	- 0.54*	- 0.61*	0.74*	- 0.17	1			
Log GDP	0.16	- 0.54*	- 0.54*	- 0.34	- 0.38*	0.19	- 0.02	0.41*	1		
GDP growth	- 0.34*	- 0.26	- 0.22	0.27	0.30	0.17	0.10	- 0.17	0.03	1	
Marginal q, q_m	0.12	- 0.40*	- 0.47*	- 0.19	- 0.17	0.44*	0.33*	0.24	0.28	0.28	1
$\hat{\eta}_j$	0.53*	- 0.32	- 0.34	- 0.38	- 0.50*	0.59*	- 0.03	0.71*	0.44*	- 0.48*	- 0.13

Note: * indicates significance at 5 percent. $\hat{\eta}_j$ is estimated by Wurgler (2000). Marginal q from Gugler et al. (2004).

Table 3 Elasticity of capital, elasticity of investments and marginal *q*

Explanatory variables:	Dependent variable: $\hat{\lambda}_j^*$	
Constant	0.405**	0.759***
	(2.38)	(3.88)
$\hat{\eta}_j$	0.929***	-
	(3.49)	
$q_{m,j}$	-	0.192
		(0.78)
R^2	0.28	0.01
No. observations	34	44

Note: *, ** and *** indicate significance at 10, 5 and 1 percent respectively. Ordinary Least Squares (OLS) is used as estimator.