Online Appendix

Accounting for Macro-Finance Trends: Market Power, Intangibles, and Risk Premia

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1 Introduction

This appendix first presents some additional empirical results, then presents and estimates a model with explicit intangible capital.

2 Additional Empirical Results

2.1 Identification

Table 1 reports the moment sensitivity, as suggested by Andrews, Gentzknow and Shapiro (2017). For each parameter (row), it shows the effect of changing each data moment on the parameter. For instance, increasing the estimate of the profit–capital ratio by 1 percentage point leads to a higher μ by about 1.88 point; or increasing the estimate of the risk-free rate by 1 percentage point leads to a lower β by about 0.20. Table 2 reports the same statistics when the parameters estimated are re-defined to be β^* instead of β. This table illustrates the recursive identification discussed in the text.

2.2 Decomposition: bounds

Table 3 reports the upper bound and lower bound of the effect of each parameter on each moment. This is calculated by consider all possible combinations of orders of changing parameters, as explained in the text, footnote 13. For instance, the effect of β on the risk-free rate RF is bounded between -1.23 and -1.21. The effect of β on the PD ratio is bounded between 19.17 and 45.66. As can be seen from the table, the bounds are fairly tight, except for the PD ratio.

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	Pi/K	Pi/Y	RF	PD	I/K	gr. TFP	gr. invt price	gr. pop.	Emp/Pop
β	0.00	-0.02	-0.20	0.04	-0.00	-0.37	0.11	-0.74	-0.00
μ	1.88	0.28	0.00	0.15	-2.48	-0.09	0.09	-0.06	-0.00
p	-0.00	0.07	-1.28	-0.07	0.00	1.81	-0.54	1.27	0.00
δ	0.00	-5.94	0.00	0.00	100.00	-145.15	146.88	-101.77	-0.00
α	-1.32	0.88	-0.00	-0.10	1.74	0.06	-0.06	0.04	0.00
g_P	-0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	100.00	0.00
g_Z	5.36	0.73	0.00	0.42	-7.09	105.34	-7.05	-1.87	-0.00
g_Q	0.00	-0.00	-0.00	0.00	0.00	-0.00	-100.00	-0.00	0.00
N	0.00	0.00	0.00	0.00	-0.00	0.00	-0.00	0.00	100.00

Table 1: Sensitivity matrix for the baseline model.

	Pi/K	Pi/Y	RF	PD	I/K	gr. TFP	gr. invt price	gr. pop.	Emp/Pop
β^*	0.00	-0.05	0.00	0.05	-0.00	-1.30	0.39	-0.91	0.00
μ	1.88	0.28	-0.00	0.15	-2.48	-0.08	0.09	-0.06	0.00
p	-0.00	0.07	-1.28	-0.07	0.00	1.81	-0.54	1.27	-0.00
δ	0.00	-5.94	0.00	0.00	100.00	-145.15	146.88	-101.77	0.00
α	-1.32	0.88	0.00	-0.10	1.74	0.06	-0.06	0.04	-0.00
g_P	-0.00	0.00	-0.00	-0.00	0.00	0.00	-0.00	100.00	-0.00
g_Z	5.36	0.73	-0.00	0.42	-7.09	105.34	-7.05	-1.87	0.00
g_Q	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-100.00	0.00	-0.00
N	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	-0.00	100.00

Table 2: Sensitivity matrix. Here the parameters are redefined with $\beta^\star$ instead of β.

	Pi/K	Pi/Y	RF	PD	I/K	gr. TFP	gr. invt price	gr. pop.	Emp/Pop
β	-2.08	0.00	-1.23	19.17	-0.00	0.00	0.00	0.00	0.00
	-1.69	0.00	-1.21	45.66	0.00	0.00	0.00	0.00	0.00
μ	2.30	4.13	0.00	0.00	-0.00	-0.17	0.00	0.00	0.00
	3.21	4.13	0.00	0.00	0.00	-0.12	0.00	0.00	0.00
p	0.68	0.00	-1.64	-26.68	-0.00	0.00	0.00	0.00	0.00
	0.84	0.00	-1.61	-5.69	0.00	0.00	0.00	0.00	0.00
δ	0.62	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
	0.74	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
α	0.00	-0.03	-0.00	-0.06	-0.00	-0.00	0.00	0.00	0.00
	0.01	-0.02	-0.00	-0.01	-0.00	-0.00	0.00	0.00	0.00
g_P	-0.00	0.00	-0.00	-5.06	-0.07	-0.00	0.00	-0.07	0.00
	0.00	0.00	0.00	-0.69	-0.07	-0.00	0.00	-0.07	0.00
g_Z	-0.32	0.00	-0.19	-12.57	-0.39	-0.27	0.00	0.00	0.00
	-0.26	0.00	-0.19	-1.96	-0.39	-0.25	0.00	0.00	0.00
g_Q	-1.27	0.00	-0.10	-7.33	-0.88	0.04	0.64	0.00	0.00
	-1.03	0.00	-0.10	-1.04	-0.87	0.08	0.64	0.00	0.00
N	-0.00	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	-1.51
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.51

Table 3: The table reports for each moment, and for each parameter, a lower bound and an upper bound on the effect of the change in parameter on the moment, where the bounds are obtained by considering all possible orders of changing parameters.

	Baseline			$IES = 1$			$IES = 0.5$		
	1984-'00	2001-'16	Diff.	1984-'00	2001-'16	Diff.	1984-'00	2001-'16	Diff.
β	0.961	0.972	0.012	0.966	0.970	0.004	0.976	0.965	-0.011
μ	1.079	1.146	0.067	1.079	1.146	0.067	1.079	1.146	0.067
p	0.034	0.065	0.031	0.034	0.065	0.031	0.034	0.065	0.031
δ	2.778	3.243	0.465	2.778	3.243	0.465	2.778	3.243	0.465
α	0.244	0.243	-0.000	0.244	0.243	-0.000	0.244	0.243	-0.000
g_P	1.171	1.101	-0.069	1.171	1.101	-0.069	1.171	1.101	-0.069
g_Z	1.298	1.012	-0.286	1.298	1.012	-0.286	1.298	1.012	-0.286
g_Q	1.769	1.127	-0.643	1.769	1.127	-0.643	1.769	1.127	-0.643
$\overline{N}$	62.344	60.838	-1.507	62.344	60.838	-1.507	62.344	60.838	-1.507

Table 4: The table reports the estimated parameter values in each of the two subsamples 1984-2000 and 2001-2016, for the baseline model, the baseline model with IES=1, and the baseline model with IES=0.5.

2.3 Results with different IES values

Our baseline results, presented in the paper, assume an IES equal to 2. (The IES is not identified given our estimation procedure, so we must set it a priori.) As we discuss in the paper, this value does not matter for some of our results, including the estimated values of several parameters (notably α or μ) or the equity risk premium estimate. It does matter however for the estimate of β and to understand the decompositions of moment changes into parameter changes such as Table 3 in the paper. We now present detailed results when the IES is set to 1 or 0.5 instead of 2. Table 4 presents the model estimates for the baseline model (i.e. $IES = 2$) as well as with $IES = 1$ or 0.5. Tables 5 and 6 present the decompositions of the target moments for $IES = 1$ and $IES = 0.5$. Table 7 presents additional moment decompositions for the baseline model and the cases with $IES = 1$ and $IES = 0.5$ and verifies that these are not affected by the choice of the IES. As can be seen from these tables, the main substantive issue affected is the decomposition of the risk-free-rate and the PD ratio. Assuming a low IES does not reduce the importance of risk in the decompositions.

3 A model with intangible accumulation

We now present an extension of our baseline model that incorporates explicitely intangible capital. We will use our estimation framework to examine how the presence of intangible capital affects our results. The extended model makes the following changes compared to the baseline model. First, the production function is now a Cobb-Douglas over both tangible and intangible capital, with respective shares α_T and α_U :

$$Y_t = Z_t K_{T,t}^{\alpha_T} K_{U,t}^{\alpha_U} (S_t N_t)^{1-\alpha_T-\alpha_U}.$$

	β	μ	p	δ	α	g_P	g_Z	g_Q	$\overline{N}$
Gross profitability	-0.67	2.76	0.00	0.68	0.00	-0.00	-0.58	-1.31	-0.00
Capital share	0.00	4.13	0.00	0.00	-0.03	0.00	0.00	0.00	0.00
Risk-free rate	-0.43	0.00	-2.12	0.00	-0.00	-0.00	-0.38	-0.21	0.00
Price-dividend ratio	9.30	0.00	0.00	0.00	-0.00	-1.52	0.00	-0.00	0.00
Investment-capital	0.00	0.00	0.00	0.47	-0.00	-0.07	-0.39	-0.88	0.00
Growth of TFP	0.00	-0.14	0.00	0.00	-0.00	-0.00	-0.26	0.06	0.00
Growth of invt. price	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.00
Growth population	0.00	0.00	0.00	0.00	0.00	-0.07	0.00	0.00	0.00
Employment-pop.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.51

Table 5: The table reports the target moments in each of the two subsamples 1984-2000 and 2001-2016, as well as the change between samples, and the contribution of each parameter to each change in moment, for the model estimated with IES=1. See text for details.

	β	μ	p	δ	α	g_P	g_Z	g_Q	$\overline{N}$
Gross profitability	1.76	2.76	-1.52	0.68	0.00	-0.00	-1.17	-1.63	-0.00
Capital share	0.00	4.13	0.00	0.00	-0.03	0.00	0.00	0.00	0.00
Risk-free rate	1.14	0.00	-3.11	0.00	-0.00	-0.00	-0.76	-0.41	0.00
Price-dividend ratio	-35.66	0.00	27.75	0.00	0.04	-2.20	11.47	6.38	0.00
Investment-capital	0.00	-0.00	-0.00	0.47	-0.00	-0.07	-0.39	-0.88	-0.00
Growth of TFP	0.00	-0.14	0.00	0.00	-0.00	-0.00	-0.26	0.06	0.00
Growth of invt. price	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.00
Growth population	0.00	0.00	0.00	0.00	0.00	-0.07	0.00	0.00	0.00
Employment-pop.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.51

Table 6: The table reports the target moments in each of the two subsamples 1984-2000 and 2001-2016, as well as the change between samples, and the contribution of each parameter to each change in moment, for the model estimated with IES=0.5. See text for details.

	Baseline			IES=1			IES=0.5		
	1984-'00	2001-'16	Diff.	1984-'00	2001-'16	Diff.	1984-'00	2001-'16	Diff.
A. MPK-RF spread									
Total spread	11.22	15.24	4.02	11.22	15.24	4.02	11.22	15.24	4.02
- Depreciation	4.55	4.37	-0.18	4.55	4.37	-0.18	4.55	4.37	-0.18
- Market power	3.39	5.55	2.17	3.39	5.55	2.17	3.39	5.55	2.17
- Risk premium	3.15	5.23	2.08	3.15	5.23	2.08	3.15	5.23	2.08
B. Rate of returns									
Equity return	5.85	4.90	-0.96	5.85	4.90	-0.96	5.85	4.90	-0.96
Equity premium	3.07	5.25	2.18	3.07	5.25	2.18	3.07	5.25	2.18
Risk-free rate	2.79	-0.35	-3.14	2.79	-0.35	-3.14	2.79	-0.35	-3.14
C. Valuation ratios									
Price-dividend	42.34	50.11	7.78	42.34	50.11	7.78	42.34	50.11	7.78
Price-earnings	17.85	25.79	7.94	17.85	25.79	7.94	17.85	25.79	7.94
Tobin's Q	2.50	3.84	1.34	2.50	3.84	1.34	2.50	3.84	1.34
D. Income shares									
Share Labor	70.11	66.01	-4.10	70.11	66.01	-4.10	70.11	66.01	-4.10
Share Capital	22.59	21.24	-1.35	22.59	21.24	-1.35	22.59	21.24	-1.35
Share Profit	7.30	12.76	5.46	7.30	12.76	5.46	7.30	12.76	5.46
E. Macroeconomy									
K/Y	2.13	2.28	0.15	2.13	2.28	0.15	2.13	2.28	0.15
I/Y	17.28	16.50	-0.78	17.28	16.50	-0.78	17.28	16.50	-0.78
Detrend Y (% chg)	–	–	-0.30	–	–	-0.30	–	–	-0.30
Detrend I (% chg)	–	–	-4.95	–	–	-4.95	–	–	-4.95

Table 7: The table reports the target moments in each of the two subsamples 1984-2000 and 2001-2016, as well as the change between samples, and the contribution of each parameter to each change in moment, for the model estimated with IES=0.5. See text for details.

Second, tangible and intangible capitals are separately accumulated, and subject to potentially different rates of depreciation and of technical progress:

$$K_{T,t+1} = \left(\left(1-\delta_T\right)K_{T,t} + Q_{T,t}X_{T,t}\right)e^{\chi_{t+1}},$$
$$K_{U,t+1} = \left(\left(1-\delta_U\right)K_{U,t} + Q_{U,t}X_{U,t}\right)e^{\chi_{t+1}}.$$

Note our assumption that both types of capital are equally risky, i.e. have the same exposure to the macroeconomic shock χ_{t+1}. Relatively little is known about the relative riskiness of tangible and intangible capital, leading us to make this assumption. Finally, the resource constraint is modified to $C_t + X_{T,t} + X_{U,t} = Y_t$.

In terms of matching this model to data, we will consider as "tangible" all capital except intellectual property products (IPP), that is, tangible is the sum of residential, equipment and structures. We will assume, similar to section 6.5 of the paper, that measured IPP investment is a fraction λ of true intangible investment:

$$X_{U,t}^{obs} = \lambda X_{U,t},$$

and hence along the balanced growth path we also have $K_{U,t}^{obs} = \lambda K_{U,t}$. The same points made in section 6.5 about the mismeasurement of GDP, profits, and the labor share apply. We estimate this model given a fixed λ, and find the same parameters as the baseline model, plus α_U, δ_U, and the growth rate of Q_U, using similar moments as the baseline model. Here mismeasurement rises over time not because λ is changing but because intangibles are growing faster than other types of capital. Specifically, we use as target moments the growth rates of investment prices in both tangible and intangible capital, the ratio of measured profits to tangible capital and the ratio of profits to intangible capital, and finally the ratio of tangible investment to tangible capital, and of intangible investment to intangible capital.

Table 8 presents the estimated parameters for different values of λ, and table 9 presents the model implications. fFirst, note that the estimated α_U is small with no mismeasurement, corresponding to the share of IPP capital in total capital: α_U is estimated to rise from 3.4% to 4.8%. The depreciation rate of intangible investment is quite high, over 20%, consistent with the usual estimates. This high depreciation is precisely the reason why the share of IPP in the capital stock is small, despite a fairly large share in investment (about 25% lately). Finally, there is progress in the technology to make IPP, but it is slower than for equipment.

Similar to the simple analysis with mismeasurement of section 6.5, we find that (i) the model without mismeasurement behaves quite similarly to the baseline model; (ii) higher mismeasurement has no effect on most parameters except μ, α_T, and α_U. Specifically, more mismeasurement leads to lower estimated markups, lower α_T, and higher α_U. Here too, rising intangibles reduce the role of the markup story while preserving the risk story.

	$\lambda = 1$			$\lambda = 2/3$			$\lambda = 1/2$			$\lambda = 1/4$		
	1984-00	2001-16	Diff.	1984-00	2001-16	Diff.	1984-00	2001-16	Diff.	1984-00	2001-16	Diff.
β	0.961	0.973	0.012	0.961	0.973	0.012	0.961	0.973	0.012	0.961	0.973	0.012
μ	1.078	1.141	0.063	1.075	1.136	0.060	1.073	1.131	0.058	1.063	1.114	0.051
p	0.034	0.062	0.028	0.034	0.062	0.028	0.034	0.062	0.028	0.034	0.062	0.028
δ_T	1.792	2.585	0.794	1.792	2.585	0.794	1.792	2.585	0.794	1.792	2.585	0.794
α_T	0.210	0.199	-0.011	0.207	0.195	-0.012	0.203	0.190	-0.013	0.191	0.174	-0.017
g_P	1.171	1.101	-0.069	1.171	1.101	-0.069	1.171	1.101	-0.069	1.171	1.101	-0.069
g_Z	0.994	0.715	-0.280	0.984	0.684	-0.300	0.973	0.652	-0.321	0.919	0.509	-0.410
g_{QT}	1.781	0.809	-0.972	1.781	0.809	-0.972	1.781	0.809	-0.972	1.781	0.809	-0.972
α_U	0.034	0.048	0.014	0.050	0.070	0.020	0.065	0.091	0.026	0.123	0.167	0.044
δ_U	22.875	23.797	0.922	22.875	23.797	0.922	22.875	23.797	0.922	22.875	23.797	0.922
g_{QU}	1.710	2.150	0.440	1.710	2.150	0.440	1.710	2.150	0.440	1.710	2.150	0.440
$\overline{N}$	0.623	0.608	-0.015	0.623	0.608	-0.015	0.623	0.608	-0.015	0.623	0.608	-0.015

Table 8: The table reports the estimated parameters in the model with intangibles, for each of the two subsamples 1984-2000 and 2001-2016, as well as the change between samples.

	$\lambda = 1$			$\lambda = 2/3$			$\lambda = 1/2$			$\lambda = 1/4$		
	1984-00	2001-16	Diff.	1984-00	2001-16	Diff.	1984-00	2001-16	Diff.	1984-00	2001-16	Diff.
A. Spread MPK-RF												
Spread	11.95	16.19	4.24	11.95	16.19	4.24	11.95	16.19	4.24	11.95	16.19	4.24
B. Rates of Returns												
Equity return	5.86	4.73	-1.13	5.86	4.73	-1.13	5.86	4.73	-1.13	5.86	4.73	-1.13
Equity premium	3.07	5.08	2.01	3.07	5.08	2.01	3.07	5.08	2.01	3.07	5.08	2.01
Risk-free rate	2.79	-0.35	-3.14	2.79	-0.35	-3.14	2.79	-0.35	-3.14	2.79	-0.35	-3.14
C. Valuation ratios												
Price-dividend	42.34	50.11	7.78	42.34	50.11	7.78	42.34	50.11	7.78	42.34	50.11	7.78
Price-earnings	17.76	25.13	7.37	17.76	25.13	7.37	17.76	25.13	7.37	17.76	25.13	7.37
Tobin's Q	2.49	3.74	1.25	2.49	3.74	1.25	2.49	3.74	1.25	2.49	3.74	1.25
D. Income Distribution												
Labor	70.11	66.01	-4.10	69.12	64.75	-4.37	68.15	63.53	-4.62	64.53	59.09	-5.44
Tangible cap.	19.52	17.48	-2.04	19.24	17.14	-2.10	18.97	16.82	-2.15	17.96	15.64	-2.32
Intangible cap.	3.14	4.19	1.05	4.64	6.16	1.52	6.10	8.06	1.96	11.55	14.99	3.44
Profits	7.24	12.33	5.09	7.01	11.95	4.95	6.79	11.59	4.81	5.96	10.27	4.32
E. Macroeconomic variables (detrended, % change)												
K/Y	2.13	2.28	0.15	2.13	2.28	0.15	2.13	2.28	0.15	2.13	2.28	0.15
I/Y	14.47	13.04	-1.43	14.47	13.04	-1.43	14.47	13.04	-1.43	14.47	13.04	-1.43
Y	–	–	-4.36	–	–	-5.16	–	–	-5.67	–	–	-6.09
I	–	–	-6.73	–	–	-7.52	–	–	-8.03	–	–	-8.45

Table 9: The table reports some moments of interest calculated in the model with intangible capital, for different values of the mismeasurement parameters, using the estimated parameter values for each of the two subsamples 1984-2000 and 2001-2016, as well as the change between samples.