An Empirical Assessment of Global Capital Productivity

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Abstract: Does the world experience a secular decline in capital productivity? Due to the long-run downward trend in interest rates, some economists do think so. However, this reasoning equates capital productivity with interest, which is a critical assumption. This paper presents a new proxy that can be used to estimate capital productivity. It is based on weighted average cost of capital (WACC), which are employed by firms in their investment appraisals as a benchmark return. The paper uses an original WACC data set for many OECD countries and for the time period 2000-2015. Data are adjusted for tax distortions and expected inflation. The principle finding is that the data do not indicate a long-run decline in capital productivity.

Keywords: Capital productivity; cost of capital; interest-growth-differential; WACC.

JEL-Classification: D24, E22, E43

1. Introduction

Macroeconomic theories often only employ a single interest rate as a proxy for capital productivity. Comparing this interest rate with the growth rate of an economy then yields the interest-growth-differential (IGD). A popular proxy for the risk-free interest rate is the rate on government bonds. The IGD is an indicator that is frequently used in the context of macro topics such as dynamic efficiency (Diamond (1965)) or the introduction or extension of pay-as-you-go public pension schemes (Aaron (1966)). Therefore, knowing if capital productivity is high, low, or follows some kind of trend is of great importance. A downward trend, for example, inducing the interest rate to fall below the growth rate, has drastic implications in such models.

Recently, Summers (2014) and von Weizsäcker (2014) pointed out that many contemporary economies are characterized by extraordinarily low interest rates and a negative IGD. When facing such a negative IGD, governments can play Ponzi games, and consequently both economists suggest raising public debt under the current circumstances. However, this argument rests on the assumption that capital markets are perfect, meaning that the interest rate equals the marginal productivity of capital. With capital market imperfections, this equality vanishes and the marginal productivity of capital can exceed the interest rate on government bonds. Dynamic efficiency then ceases to depend on the IGD. Instead, the difference between capital productivity and the growth rate becomes relevant, as shown by Homburg (2014) in a model with uncertainty. In the following, this difference will be referred to as the productivity-growth-differential (PGD). In his paper, Homburg uses long-term interest rates of corporate bonds as a proxy for capital productivity because, according to him, better measures such as the weighted average cost of capital (WACC) are not available at the national level.

The present paper makes progress by providing a direct estimate of the expected marginal productivity of capital. This novel approach incorporates a financial economics framework. It uses the aforementioned WACC, a measure provided for and used by practitioners in project financing. The WACC is used as a benchmark return that projects need to meet or exceed in order to be undertaken. Projects that do not yield a positive net present value at given WACC are rejected. Therefore, the WACC represents the return on marginal projects, or in other words: the marginal productivity of capital. To obtain a national estimate that is conceptually similar to the capital productivity in macro models, the WACC data are adjusted for tax effects and converted to real rates using inflation expectations. Using this observable measure, the PGD can then be estimated as well.

Before proceeding, it should be pointed out that the capital productivity measure proposed here is only loosely related to capital productivity measures calculated from national accounts. First, it is an expected rather than an ex post measure. Second, it refers to the marginal productivity rather than to the average productivity. Third, national account data are heavily influenced by residential construction which often has very low yields, specifically in the case of owner-occupied housing where the value for housing services is imputed. The capital productivity measure presented here is free from these distortions, and as a result the estimates might defer from capital productivity approximations derived from national accounts. This is simply due to the difference in the underlying concept of how capital productivity should be measured. When assessing dynamic efficiency, one needs a measure for the expected marginal productivity of capital. Ex post measures of average capital productivity inferred from national accounts do not appear useful in this context, see Homburg (2014).

The paper is organized as follows. Section 2 provides a theoretical background on the WACC and shows how the original data need to be adjusted in order to be useful proxies of the expected marginal productivity of capital. Afterwards, data sources and computation are presented in Section 3. Section 4 puts the new method to the test for selected countries and shows that, surprisingly, the implied PGD are still positive in the aftermath of the Great Recession. Section 5 concludes.

2. WACC and Capital Productivity

The WACC represents the minimum return a project must yield to satisfy its shareholders and creditors. Companies use a mix of debt and equity financing, which are associated with different costs. Knowing its cost of capital is crucial for any investment decision a firm undertakes. The cost of equity represents the opportunity cost of the firm's shareholders and is typically higher than the cost of debt. Equity is riskier than debt because it represents an unpredictable residual claim, and it becomes even riskier as the debt-to-equity-ratio of a firm increases. Therefore, shareholders demand a higher return than bondholders. The cost of capital for the firm is an average of these different costs, weighted by the respective share of equity and debt:

(1) $$r_{wacc} = \frac{E}{E+D} r_E + \frac{D}{E+D} r_D (1-\tau_c) \quad ,$$

where E is the market value of equity and D the market value of debt. r_E and r_D denote the equity cost of capital and the debt cost of capital, respectively. τ_c is the marginal corporate tax rate. The equity cost of capital is typically derived using the Capital Asset Pricing Model (CAPM) introduced by Sharpe (1964), all other values can be taken from the firm's financial statement. For more details on the derivation and analysis of the WACC and its components, see Brealey et al. (2014; 479-484).

When deciding whether or not to take on a project, the WACC represents the benchmark for the return that the project has to produce. It is thus the relevant rate for firms when making investment decisions. Investments with a lower return than the WACC are rejected while investments with a higher return are approved. As such, an approach based on WACC data seems to be a much better suited approximation for capital productivity than e.g. interest rates on loans, which neglect the equity-side of a firm's financing mix.

In order to bring this financial concept into line with macroeconomic models, a few adjustments need to be made. The WACC is a nominal rate that includes taxes. In contrast, the capital productivity known in the macro context is a real rate that does not include taxes. Therefore, the tax effects need to be extracted from the WACC before converting it to a real rate. The first step of this process is also referred to as grossing up and simply requires one to divide the WACC by the corporate income tax factor. This calculation is also carried out by financial practitioners and is described by the following equation:

(2) $$r_{waccp} = \frac{r_{wacc}}{1 - \tau_c} \quad .$$

The conversion from nominal to real rate is carried out using inflation expectations according to the equation:

(3) $$r_{waccpr} = \frac{1 + r_{waccp}}{1 + \pi^e} - 1 \quad ,$$

where π^e denotes expected inflation and r_{waccp} is the pretax but still nominal WACC. The resulting r_{waccpr} is a new, macro compatible measure for capital productivity based on an indicator from the financial economics background. It reflects the cost actually borne by firms for the capital they use for investment. In the following, national estimates for capital productivity based on this approach will be calculated. Several countries are taken into consideration to observe how these rates behaved since the beginning of the millennium. Additionally, a comparison with the growth rates of these economies is conducted to illustrate the nature and development of the resulting PGD. The next section introduces the data sources and computation of the different rates.

3. Data

This paper provides an aggregated estimate for the capital productivity of nearly all OECD countries[1] from 2000-2015. Additionally, a closer look will be taken at the USA, Japan, Germany, and Spain, as well as the eurozone[2]. The USA are shown in more detail as one of the major economies worldwide and to examine whether or not Summers (2014) is correct in his assessment that the USA could profit from higher public debt. Japan was selected due to its unique economic experience over the past decades. Germany was chosen as an illustration of developed countries that have overcome the Great Recession. In contrast, Spain belongs to the group of eurozone countries that are still struggling with its aftermath. A summary of the databases used including specifications on the data can be found in Appendix B.

Data on the WACC of a large number of firms is available at the Bloomberg database, which started collecting it in 2000. The data was taken for two dates each year, the 30th of June and the 31st of December. A total of 3783 firms listed in leading stock markets from the countries observed was taken into account. A list of the number of firms by stock market can be found in Appendix A. For each point in time, a simple arithmetic average for all companies belonging to one country was calculated, giving equal weight to each company. This yielded the WACC time series for each country under consideration.

To determine the pretax WACC, national values for the combined corporate tax rate of each country were obtained from the "Table II.1. Corporate Income Tax Rate" dataset from the OECD database. Inflation expectations were taken from the "ifo World Economic Survey" conducted by the ifo Institute. The survey on the expected inflation rate in the current year has been taken on a quarterly basis since 1991. The average of the first two quarters and of the last two quarters of each year was calculated to complement the biannual WACC data. Dividing the WACC by the tax factor of the respective country and transforming it to a real rate using the ifo estimate of expected inflation yielded the measure for capital productivity.

For the growth rates, quarterly data on nominal gross domestic product (GDP) was taken from the OECD database, starting with the first quarter of 1999 and ending with the last quarter of 2015, if available. The time series reports the GDP calculated via the expenditure approach (B1_GE), measured in millions of national currency at current prices, quarterly levels, seasonally adjusted (measure: CQRSA). This data was then converted to biannual data from which a year-over-year calculation yielded the annual growth rates for all countries. The six month intervals correspond to the biannually reported WACC values. The nominal rate was converted to a real growth rate using the inflation expectations from the ifo Institute.

[1] Italy had to be excluded due to data unavailability.

[2] Again excluding Italy due to data unavailability. Eurozone countries that are not OECD countries and therefore not included in the estimate are Cyprus, Latvia, and Malta.

Unfortunately, this calculation was not possible for the derivation of the two aggregates, as the GDP data for Greece and South Korea was not available at quarterly levels. In these cases, annual GDP data was then used for the OECD and eurozone calculation. When combining countries, the different sizes of the economies were considered. The countries were weighted according to their PPP-converted GDP in the base year 2000 as reported in the Penn World Tables. This applies to the capital productivity data as well as the growth rates to ensure equal treatment of the two rates.

It should be noted that the WACC is not reported for all companies all of the time. As a result, the time series starts later for some countries[3] and reported WACC data might be scarce, especially for the stock markets that only list few companies. For all countries, the number of companies for whom the WACC is reported increases over time.[4] One could argue that taking only a selected number of listed companies to derive a national value for the WACC is flawed due to a bias in the data selection. However, this objection appears to be less problematic when assuming that listed firms with sound finances are more likely to get access to cheaper loan financing. As a result, any bias of the national estimate based on these firms is due to underestimating the capital productivity of the nation as a whole. Therefore, if capital productivity based on WACC exceeds growth, the true rate and with it the PGD should be even higher. Additionally, data availability becomes an issue the more firms one wants to include in the estimates. While a more extensive analysis of the WACC data within the different countries would surely improve accuracy, such an undertaking has to be left to future research when more data is available.

4. Empirical Results

This section presents the results obtained from calculating capital productivity based on WACC data as described above. It should again be pointed out that the values presented here are expected values as they are derived using inflation expectations and that one can expect them to differ from the values inferred from national account data. Specifically, expectations of low inflation or even deflation will cause capital productivity to rise substantially.

[3] This concerns Hungary (starts 06/30/2002), Iceland (starts 12/31/2000), Slovakia (starts 12/31/2000), and Slovenia (starts 12/31/2003).

[4] A detailed breakdown of the reported numbers per country per period is provided in Appendix A.

Figure 1 shows the capital productivity and growth rate of all countries considered in the analysis. On average, capital productivity is 9.9% while the growth rate is 1.5%. This indicates dynamic efficiency. The PGD, which can be interpreted as an indicator for budget tightness, is positive at all times and increases sharply in 2008. This is driven by the decreasing growth rate during the Great Recession. It stays above pre-crisis levels even after the growth rate recovers due to an increase in capital productivity. The latter peaks at the end of 2010 at 14.2% and stays between 9-11% for the remainder of the time series. The PGD is somewhat higher during this time compared to the first half of the timeframe under consideration. This increase illustrates the tightening resource constraint faced by firms as a result of the crash in 2008/2009. A downward trend in capital productivity is not visible. Indeed, productivity seems to rise slightly: the average of the period from 2000-2007 is about 2% below the average between 2007 and 2015.

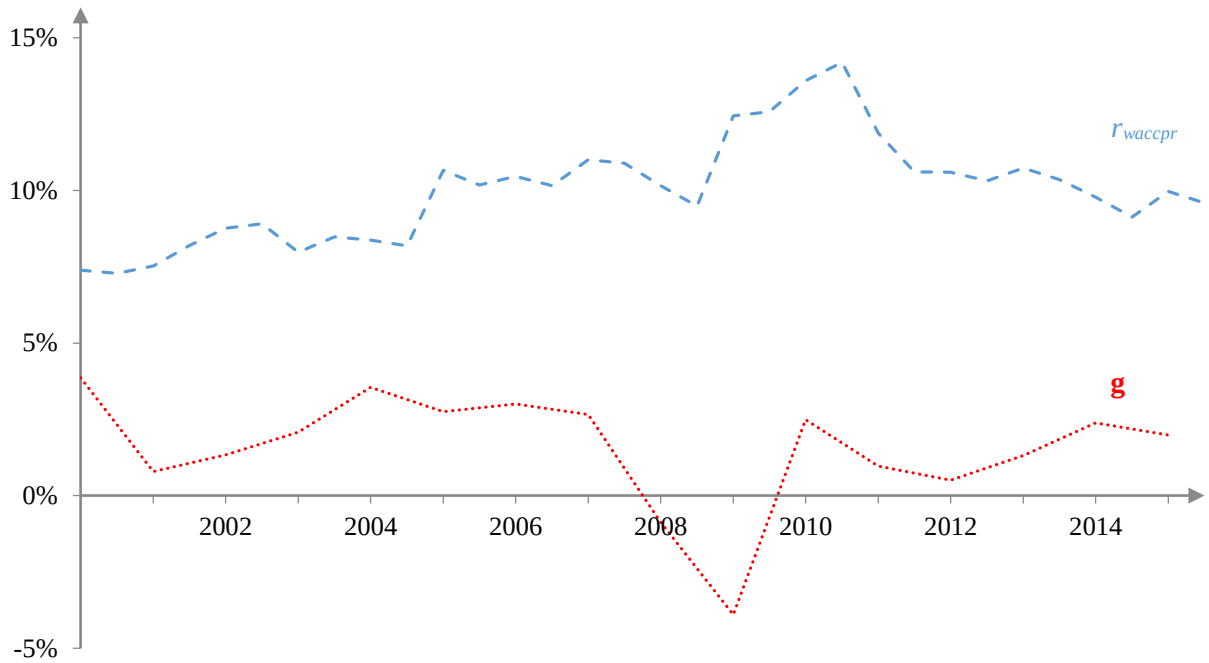

Figure 1: OECD-Sample Capital Productivity and Growth.

This selection of countries facilitates a general assessment of capital productivity across a large and diversified sample of countries, involving emerging as well as developed economies. Figure 2 shows the results for a smaller sample comprising selected eurozone countries.[5] The findings are very similar to the ones presented in Figure 1. Capital productivity averages at 9.0%, the growth rate at 0.9%. The former peaks in 2010 following the recovery of the growth rate.

[5] The omitted countries, as stated in footnote 2, are Italy, Cyprus, Latvia, and Malta.

Compared to Figure 1, the difference of the PGD before and after the crisis is more pronounced. From 2000-2007, the PGD is between 5.8-7.5%. In the following years it is slightly above 10% with a maximum of 13.2% in 2009. During the last two years under consideration it falls below 10% due to the recovering growth rate, reaching pre-crisis levels in 2015 at 6%. There seems to be no upward or downward trend concerning capital productivity.

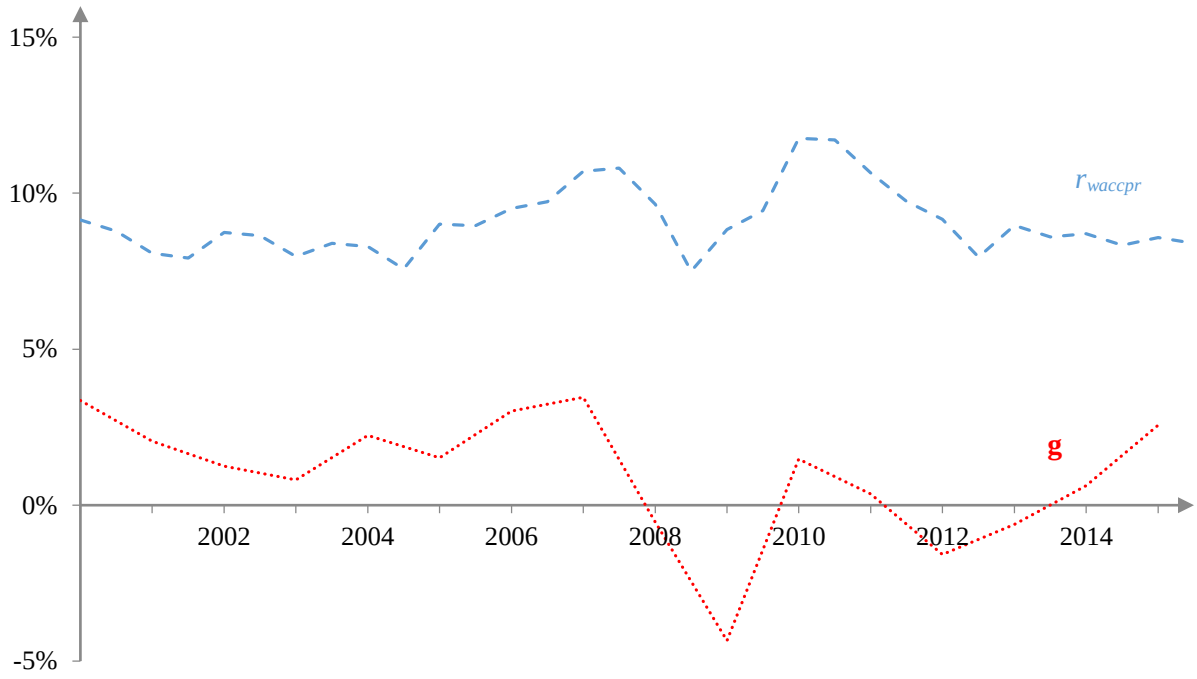

Figure 2: Eurozone Capital Productivity and Growth.

To gain further knowledge of the nature of the capital productivity measure and country-specific influences, it is useful to examine the countries individually. Figure 3 shows the capital productivity and growth rate for selected countries, namely the USA, Japan, Germany, and Spain. Table 1 summarizes the average capital productivity and growth rate data.

Table 1: Average Capital Productivity and Growth for Selected Countries.

Country	Capital Productivity	Growth Rate
USA	11.7%	1.5%
Japan	11.0%	-0.3%
Germany	9.6%	0.7%
Spain	7.8%	1.2%

Once again capital productivity exceeds the growth rate. This applies to all countries throughout the time series. For the USA and Japan, capital productivity is higher on average compared to the other countries and aggregates. Japan displays the highest capital productivity found in the sample presented here at 20.2% at the end of 2010. Almost all other countries' capital productivity – including the two aggregates presented above – also peak at the end of 2010. The only exception is Spain, where capital productivity is at its highest level at the end of 2007.

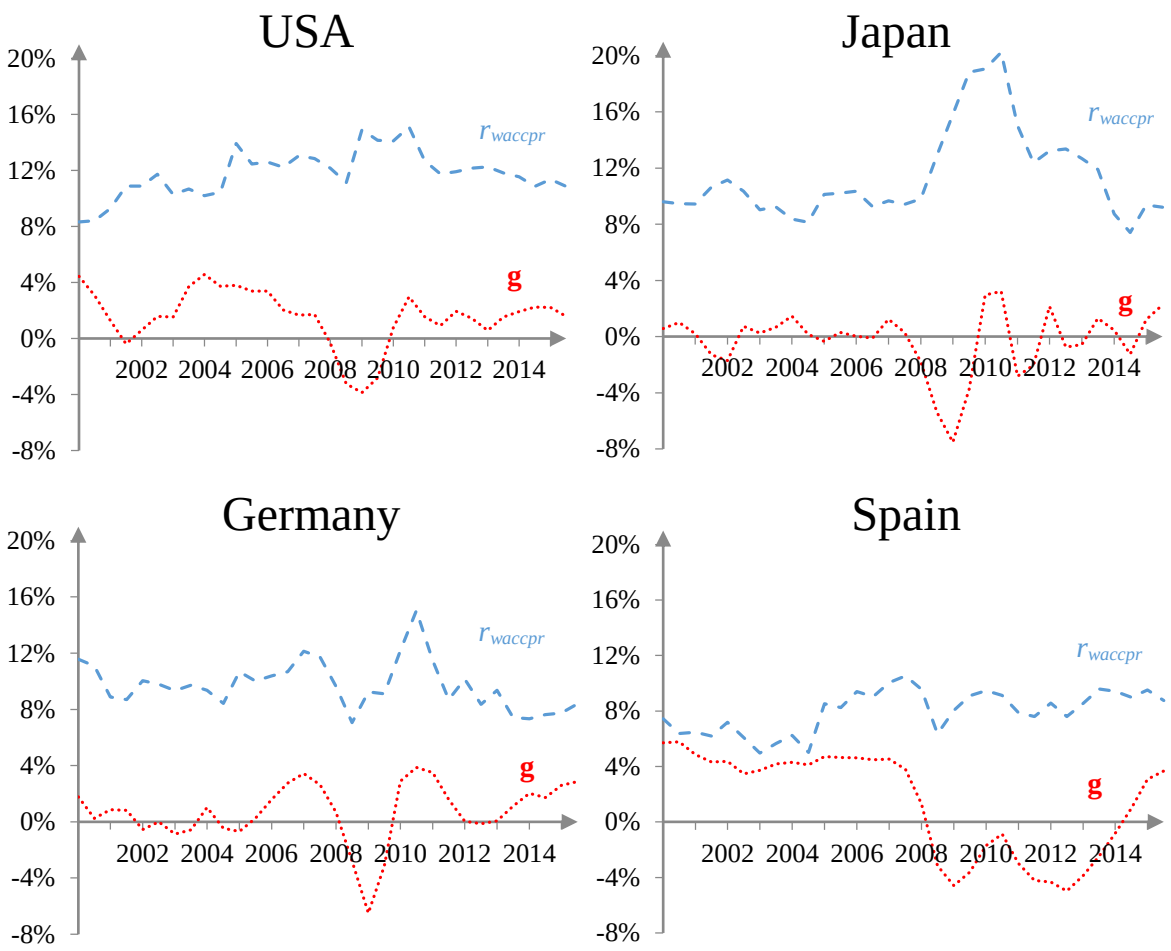

Figure 3: Capital Productivity and Growth for Selected Countries.

Spain differs from the other countries in other aspects as well. While for all other countries and the two aggregates the PGD is maximal in the summer of 2009, Spain's PGD peaks three years later. In comparison to the rest of the sample Spain's PGD undergoes the most far-reaching change. Up until 2005, its PGD does not exceed 3%, a rather low value compared to the rest of the data set. This is mainly driven by a relatively high growth rate, though the capital productivity level in Spain is also lower compared to the other countries. The PGD then quickly increases, first from higher capital productivity and then as a result of a sharp decrease in the growth rate. Between 2009 and 2014 it continually reaches at least 10%. By the end of 2015 it has declined to 5.1% due to a steady rise in the growth rate since 2012.

As mentioned before, the PGD can be interpreted as a measure of intertemporal budget tightness. During the first years considered here, when the PGD was even close to zero at times, Spanish firms' budget constraints were thus a lot more relaxed compared to firms in e.g. Germany or the US. Looking at data on loans given out to non-financial corporations in Spain shows that this is already enough to cause excessive loan financing. In January 2003, loans to non-financial corporations amounted to €343 billion.[6] By the end of 2006, this number had more than doubled to €760 billion. It kept rising until it reached its maximum in April 2009 at €971 billion. 2009 is also the year where the PGD rapidly crossed into double digits, making it harder for firms to continue their financing strategy. As a result, the amount of outstanding loans has steadily declined to €532 billion by the end of 2015.

In contrast, Germany is the only country where the PGD is lowest towards the end of the time series. This is due to a lower level of capital productivity. However, this decline does not follow an apparent secular downward trend but rather an episode of lower productivity that can also be identified in 2008. Capital productivity peaks at 15.0% in 2010, the PGD takes its maximum in 2009 at 15.7%.

The USA have the highest capital productivity on average with a peak at 15.1% in 2010, just slightly above Germany, whose capital productivity is 2 percentage points lower on average. For the USA, capital productivity is higher at around 11% at the end of the time series compared to its starting level in 2000 of below 10%. The PGD is nowhere near negative values throughout the entire time series, negating the possibility of successful Ponzi schemes by the government as proposed by Summers (2014).

Japan is a country that is sometimes believed to be dynamically inefficient (e.g. Ahn (2003)), and its economic experience over the past decades is a mystery to many economists, see Homburg (2015). Nevertheless, it neatly fits the pattern already expressed by the other countries: a capital productivity level that always exceeds the growth rate, ensuring dynamic efficiency. At 23.3% in 2009, the PGD is the highest in the sample presented here.

All in all, no evidence for a downward trend can be found in any of the countries or aggregates under consideration. Instead, some similarities were uncovered, namely the simultaneous maximization of the PGD in 2009 or the synchronized peak of capital productivity at the end of 2010 for all countries but Spain. A possible reason for this second phenomenon could be that after the recession, shareholders demanded a higher return due to increased perceived risk and this drove up the WACC through an increase in r_E. The delay in this reaction is not surprising as it takes time for expectations to adjust.

[6] Retrieved in March 2016 from the ECB's Statistical Data Warehouse.

Conclusion

This paper introduced a new measure of capital productivity to assess dynamic efficiency based on WACC, an instrument from the financial economics field. An application of this approach to selected countries and a comparison with each country's growth rate yielded several interesting findings. Some of these might also contribute to the debate on declining interest rates and capital productivity.

First, it can be shown that even though different economies and aggregates were considered, some similarities stood out. The PGD reached its peak at about the same time for all countries when growth rates crashed in 2008/2009. Capital productivity then rose sharply in almost all cases after the Great Recession, coinciding with the recovery of growth rates.

The second insight concerns policy implications. The high PGD during and after the Great Recession put an additional strain on the economies. Forcing controllable interest rates down is no remedy for such a situation, as can be seen by the complete unresponsiveness of capital productivity to low interbank rates which have been enforced since 2009 in both the US and the eurozone. It is therefore also questionable if the ECB's current quantitative easing will succeed in boosting investment in eurozone countries when the rate that is relevant for firms' investment decisions is unaffected by such measures. So far no effect on the level of loans given out to non-financial corporations in the eurozone is visible.

The third and most important result of this paper is that according to the new WACC-based measure, capital productivity is not anywhere near zero and that there is no reason to believe that it is declining, leading the PGD to be negative. On the contrary, looking at the aggregate of almost all OECD countries suggests that if there is indeed a trend to be identified, it is more likely to be upward than downward.

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Appendix A – Overview of WACC Data

Country	Stock Market	No. of members	First WACC data collected
Australia	S&P/ASX 300	297	30.06.2000
Austria	ATX	20	30.06.2000
Belgium	BEL 20	20	30.06.2000
Canada	S&P/TSX Composite Index	251	30.06.2000
Chile	IPSA Index	40	30.06.2000
Czech Republic	CTX Index	14	30.06.2000
Denmark	OMX Copenhagen 20	20	30.06.2000
Estonia	OMX Tallinn Index	16	30.06.2000
Finland	OMX Helsinki All Share Index	130	30.06.2000
France	CAC 40	40	30.06.2000
Germany	DAX, MDAX, SDAX	130	30.06.2000
Greece	Athens Stock Exchange General Index	60	30.06.2000
Hungary	Share Index of Budapest Stock Exchange	14	30.06.2002
Iceland	NASDAQ OMX Iceland	14	31.12.2000
Ireland	ISEQ Overall Index	48	30.06.2000
Israel	TA-100 Index	101	30.06.2000
Japan	Nikkei 225	225	30.06.2000
South Korea	KOSPI	762	30.06.2000
Luxembourg	LuxX Index	10	30.06.2000
Mexico	IPC	35	30.06.2000
Netherlands	AEX	25	30.06.2000
New Zealand	NZX All	115	30.06.2000
Norway	OBX Index	25	30.06.2000
Poland	WIG 20	20	30.06.2000
Portugal	PSI 20	20	30.06.2000
Slovakia	SAX Index	7	31.12.2000
Slovenia	SBITOP	8	31.12.2003
Spain	IBEX 35	35	30.06.2000
Sweden	OMX Stockholm 30	30	30.06.2000
Switzerland	SMI	20	30.06.2000
Turkey	ISE-100 Index	99	30.06.2000
United Kingdom	FTSE 100	101	30.06.2000
USA	Russell 1000	1031	30.06.2000

No. of firms with WACC data	USA	Germany	Spain	Japan	Eurozone	Total
30.06.2000	592	27	18	11	183	1236
31.12.2000	722	36	18	21	215	1982
30.06.2001	739	57	20	25	283	1938
31.12.2001	749	63	21	33	301	2021
30.06.2002	759	73	22	35	347	2267
31.12.2002	762	76	21	62	351	2390
30.06.2003	763	88	22	116	377	2492
31.12.2003	774	90	22	151	382	2590
30.06.2004	792	93	23	179	399	2720
31.12.2004	800	93	22	182	402	2820
30.06.2005	815	96	23	194	418	2930
31.12.2005	830	99	23	199	429	3001
30.06.2006	836	106	23	208	448	3097
31.12.2006	851	107	25	208	458	3154
30.06.2007	867	113	27	213	482	3213
31.12.2007	881	117	26	214	487	3283
30.06.2008	894	117	28	217	498	3329
31.12.2008	893	118	28	217	504	3360
30.06.2009	899	118	28	218	510	3388
31.12.2009	920	118	29	218	511	3448
30.06.2010	928	122	31	220	522	3503
31.12.2010	948	124	31	220	527	3552
30.06.2011	958	126	35	221	549	3599
31.12.2011	983	126	35	221	549	3635
30.06.2012	984	127	35	221	552	3648
31.12.2012	1002	129	35	221	555	3683
30.06.2013	1009	130	35	224	557	3710
31.12.2013	1019	130	35	224	560	3730
30.06.2014	1022	130	35	223	479	3523
31.12.2014	1027	130	35	225	567	3728
30.06.2015	1028	129	35	225	562	3717
31.12.2015	1026	128	35	225	559	3701

Appendix B – Data Sources

Data	Source	Specifications
WACC	Bloomberg Database	Biannual data
Corporate Tax Rate	OECD Database, http://stats.oecd.org/	Table II.1. Corporate Income Tax Rate; Annual data
Expected Inflation	ifo World Economic Survey, https://www.cesifo-group.de/de/ifoHome/publications/journals/CESifo-World-Economic-Survey.html	Quarterly data; Also available at Thomson Reuters Datastream, Indicator: WES: Expected Inflation Rate (%, avg. of year)
Nominal GDP	OECD Database, http://stats.oecd.org/	Subject: B1_GE, Measure: CQRSA; Quarterly data if available, otherwise annual data
PPP-converted GDP	Penn World Tables 7.1, https://research.stlouisfed.org	Indicator: tcgdp 'Total PPP Converted GDP, G-K method, at current prices; Unit: million International dollar; Annual data
Loans to Non-Financial Corporations	ECB Statistical Data Warehouse, http://sdw.ecb.europa.eu	Series BSI.M.ES.N.A.A20.A.1.U2.2240.Z01.E