Depreciation and Net Capital Services: How much do Intangibles Contribute to Economic Growth

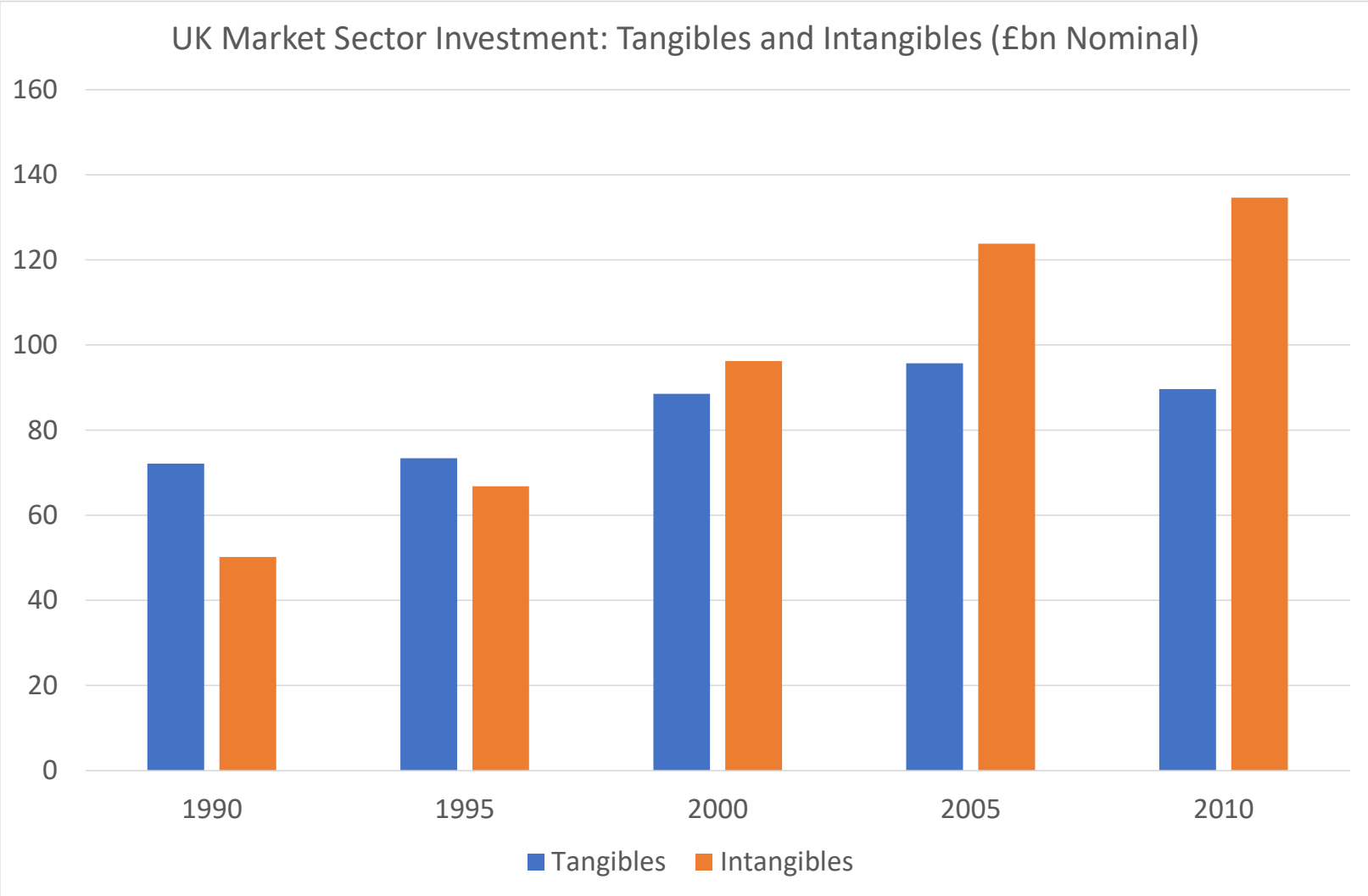
by Mary O'Mahony and Martin Weale

May 2021

Contents

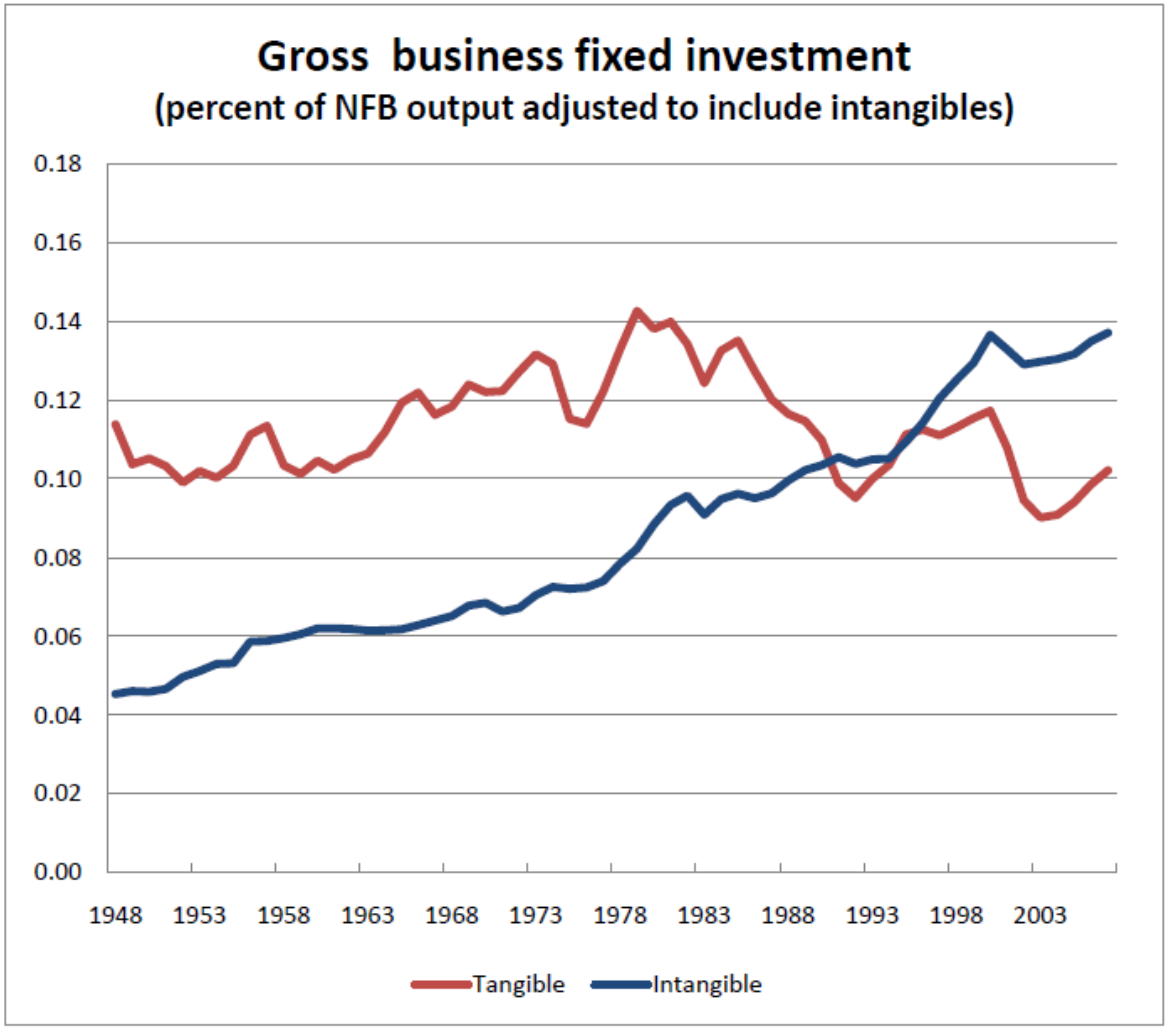
- Intangibles and gross capital formation
- Growth Accounting with Depreciation
- Four components of gross capital formation
- The Importance of Intangibles in the UK and US
- Contributions to Economic Growth from Depreciation and Net Capital Services

Tangible and Intangible Investment in the UK



Source: Goodridge, Haskell and Wallis (2014)

Tangible and Intangible Investment in the US



Source: Corrado and Hulten (2010)

Growth Accounting for the United States with Intangibles

	1948-1973	1973-1995	1995-2007
Output per Hour	2.99	1.56	2.76
Tangible Capital	0.76	0.52	0.64
Intangible Capital	0.30	0.39	0.73
Labour Composition	0.15	0.26	0.20
TFP	1.78	0.39	1.20
Memo: TFP No intangibles	1.92	0.53	1.63

Source: Corrado and Hulten (2010)

How helpful is GDP?

- These data raise a question of the utility of growth accounting. If some forms of capital depreciate rapidly, increases in investment in these will have a powerful effect on GDP, but a much more limited effect on net domestic product (NDP).
- It is it therefore desirable to distinguish contributions to depreciation from contributions to NDP.
- As a footnote we observe that the first UK national accounts, published in 1941, focused on net income and net capital formation rather than the gross figures.
- The distinction is particularly important when trying to understand changes to economic well-being.

Data

- We work with data for the United Kingdom and United States
- The data on tangible gross capital formation and business sector output are taken from the EUKLEMS data set
- The data on intangible gross capital formation are taken from the INTANINVEST dataset
- Estimates of capital stock are calculated using a perpetual inventory and the depreciation rates shown in the next slide.
- The starting values for tangible capital stocks are based on gross capital formation data in 1970, and the inventory is run forward from then.
- The stocks of intangibles at the end of 1995, when the INTANINVEST data start, are taken as gross capital formation in 1995 divided by the relevant depreciation rate.

Depreciation Rates of Different Types of Capital (% p.a.)

INTANINVEST		EUKLEMS	
Software etc	31.5%	Computing Equipment	31.5%
Artistic Originals	30%	Communications Equipment	11.5%
Design	20%	Transport Equipment	18.5%
Financial Products	20%	Other machinery	12.6%
R and D	15%	Non-residential structures	3.4%
Brands	55%	Cultivated Assets	19.3%
Organisational Capital	40%		
Training	40%		

Decomposing Gross Capital Formation and Capital Services

Depreciation and Growth

Deprecation contributes to GDP but growth in depreciation cannot be seen as an indicator of underlying economic growth.
Look at four components of capital formation

- Intangible Net Capital Formation
- Intangible Depreciation
- Tangible Net Capital Formation
- Tangible Depreciation

Depreciation and Capital Services

Modern growth accounting studies the contribution of capital services. Accordingly we develop a framework to distinguish the depreciation services from the net capital services provided by each type of capital. We then aggregate to give the four categories above

Measures of User Cost

- We assume that volumes of each type of capital service provided by each type of capital good are proportional to the capital stocks employed in production.
- $q^G_{i,t}$ represents the price of gross capital services provided by capital good i with price p_i
- r_t measures the nominal return on capital and is assumed to be the same for all capital goods.
- $q^G_{i,t} = r_t p_{i,t} + \delta_i p_{i,t} - (p_{i,t} - p_{i,t-1})$
- The price of net capital services is given as $q^N_{i,t} = q^G_{i,t} - \delta_i p_{i,t}$ with the price of depreciation services $q^D_{i,t} = \delta_i p_{i,t}$

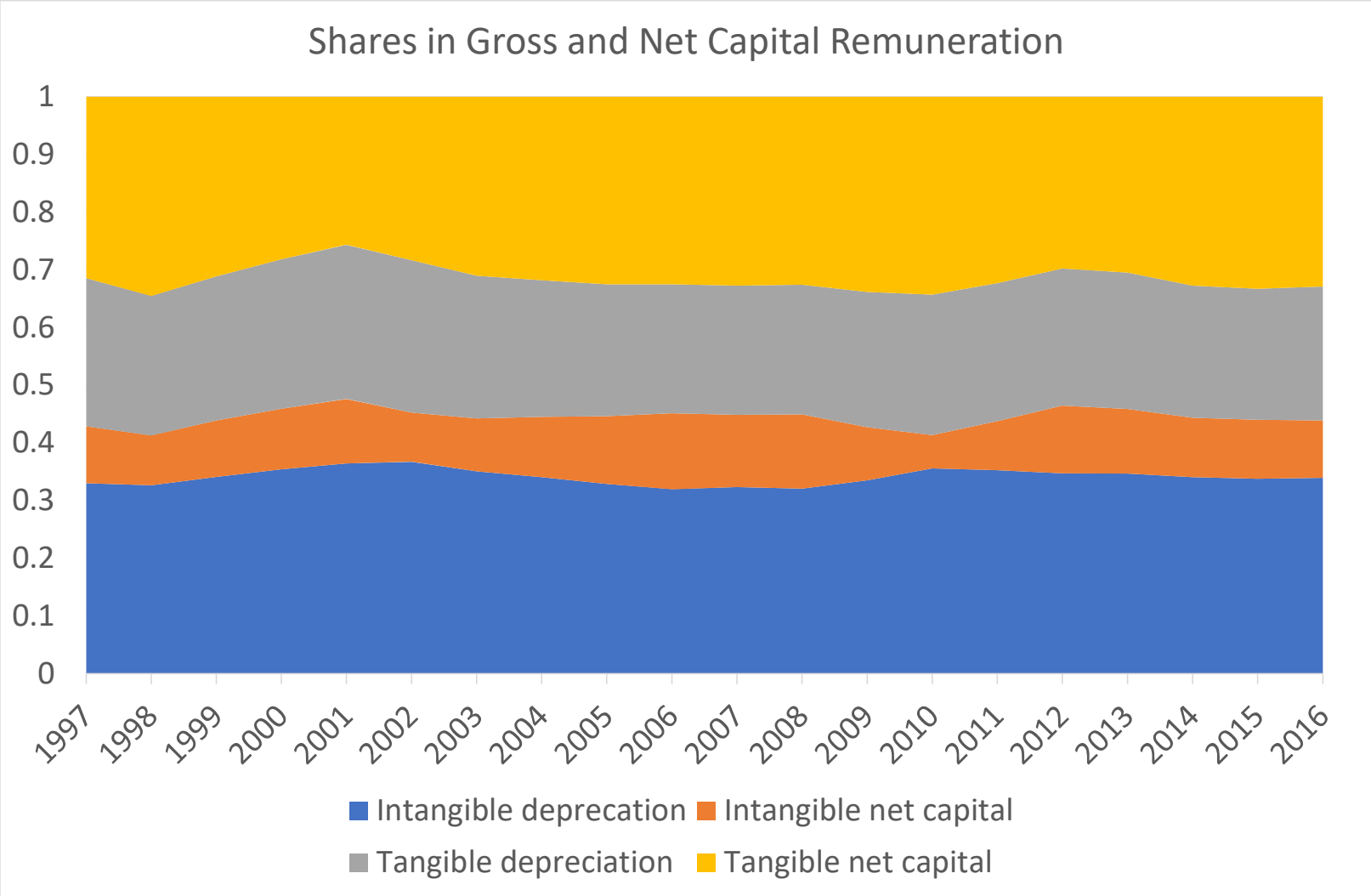
Indices of Capital Services

- We define growth in a Divisia index of gross capital services, K^G as $d\log(K^G) = \sum_i \frac{q_i^G k_i}{\sum q_i^G k_i} d\log(k_i)$
- Similarly we can define growth in indices of net capital services as $d\log(K^N) = \sum_i \frac{q_i^N k_i}{\sum q_i^N k_i} d\log(k_i)$
- and of depreciation services as $d\log(D) = \sum_i \frac{q_{i,t}^D k_i}{\sum_{i,t}^D k_i} d\log(k_i)$
- Then we can show that the following relationship holds $d\log(K^G) = \frac{\phi^N}{\phi^G} d\log(K^N) + \frac{\phi^G - \phi^N}{\phi^G} d\log(D)$ where ϕ^G the share of gross capital income in GDP and ϕ^N the share of net capital income in GDP.

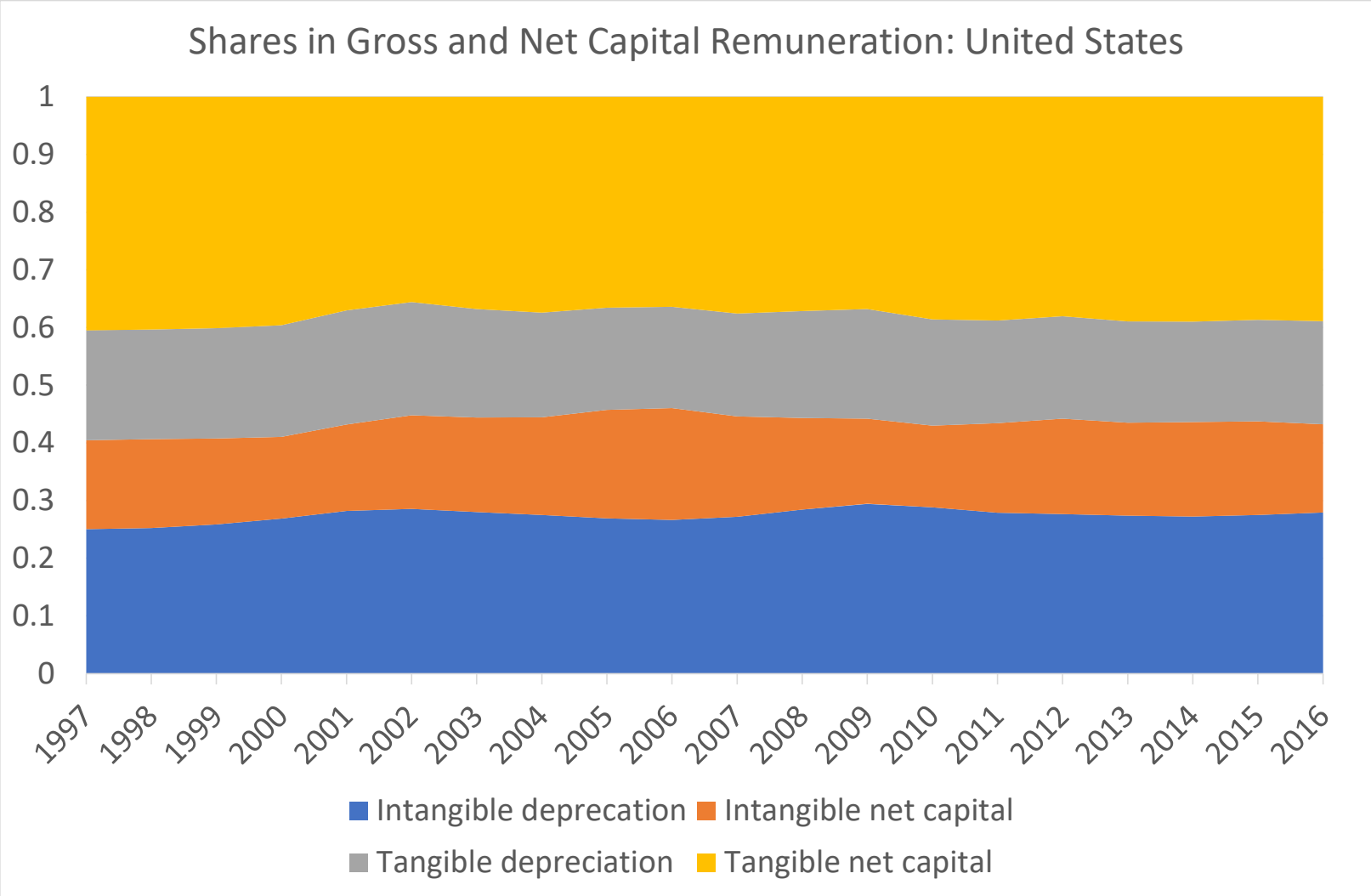
Accounting for Growth in GDP and NDP

- The standard growth accounting relationship is
  $d\log(Y^G) = \phi^G d\log(K^G) + \phi^L d\log(L) + \textit{residual}$
- We decompose this as
  $d\log(Y^G) = \phi^N d\log(K^N) + (\phi^G - \phi^N) d\log(D) + \phi^L d\log(L) + \textit{residual}$
  giving contributions of net capital services and depreciation services to growth in GDP.
- It is also possible to account for the growth of a Divisa index of net output as
  $d\log Y^N = \frac{\phi^N}{(1-\phi^G+\phi^N)} d\log(K^N) + \frac{(1-\phi^G)}{(1-\phi^G+\phi^N)} d\log(L) + \frac{\textit{residual}}{(1-\phi^G+\phi^N)}$
- Here *residual* remains the residual identified in the decomposition of the growth of Y^G
- Further we may compute indices of net capital services and depreciation services for different categories of capital good in the same way as is often done with gross capital services.
- These decompositions allow us to identify the contributions of the four different types of capital services to growth in GDP.

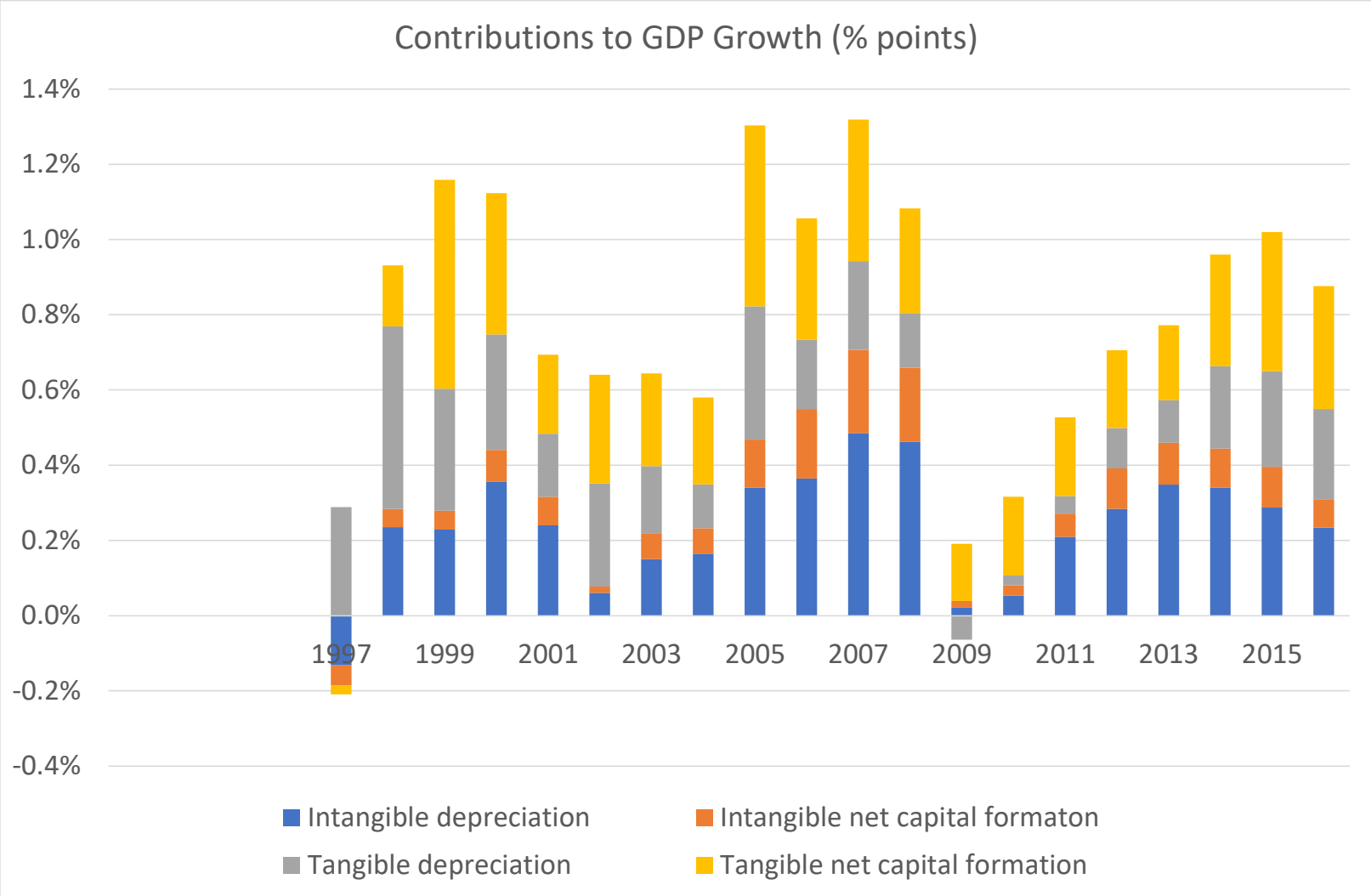
Gross and Net Capital Remuneration: UK



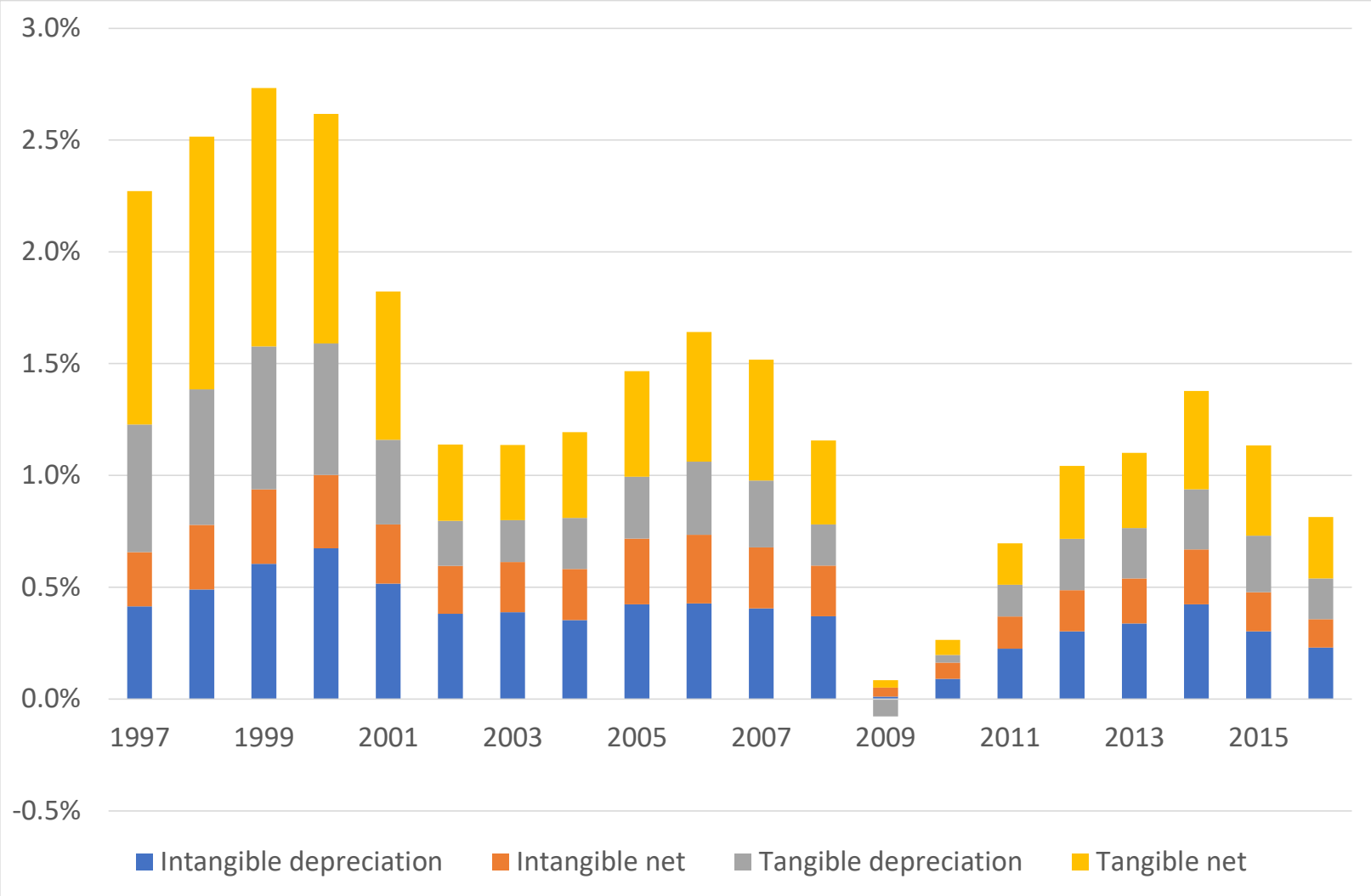
Gross and Net Capital Remuneration: US



Contributions to Growth in GDP (% p.a.), UK



Contributions to Growth in GDP (% p.a.), US



UK and US Compared

	UK		US	
	1997-2007	2008-2016	1997-2007	2008-2016
Intangible Depreciation	0.23	0.25	0.46	0.25
Intangible Net Capital Formation	0.08	0.09	0.27	0.16
Tangible Depreciation	0.26	0.12	0.39	0.16
Tangible Net Capital Formation	0.29	0.25	0.70	0.27

Table: Contributions of Capital Services to Output Growth (percentage points per annum)

Conclusions

- A focus on the share of intangibles in gross fixed capital formation substantially overstates the importance of intangibles to economic growth.
- Intangibles account for over 40% of the total capital remuneration in the UK, but intangibles earn only about 25% of net capital remuneration.
- Similar remarks apply to the US. 43% of gross capital but only 30% of net capital remuneration relates to intangibles.
- The contribution of net intangible capital services to growth in GDP over the period 2008-2016 was only just over a quarter of the total contribution of net capital. In the United States the ratio is just over 1/3.
- A general conclusion is that, while the contribution of intangible investment to economic growth is important, from an economic well-being perspective it might be beneficial to draw attention to shares in net rather than gross fixed capital services.