



ACCOUNTING FOR FREE DIGITAL SERVICES AND HOUSEHOLD PRODUCTION - AN APPLICATION TO FACEBOOK

Paul Schreyer
Deputy Director
OECD Statistics and Data Directorate

EMG Workshop
UNSW December 2019



Overview

1. This Issue – valuing ‘free’ digital services
2. Who produces? And how does production take place?
3. Extended Measure of Activity
4. Discussion and conclusions





1. The issue – valuing free digital services



BCDEF

- Brynjolfsson, Collis, Diewert, Eggers and Fox (2018)
 - Incentive compatible choice experiments
 - Willingness to forego digital services, in particular access to Facebook:
 - around 500\$/year: shadow price (marginal consumer surplus) not in NA



Photo by Thought Catalog on Unsplash



BCDEF

- BCDEF (a) integrate findings into the **GDP price index** using a reservation price approach
- Real “GDP-B” growth $> 0.5\%$ points/year more than U.S. GDP
- BCDEF (b) integrate findings into **nominal GDP measure** (total income approach) without modifying price indexes
- Similar effects for “GDP-B”





But who produces?
And how does production take place?



A product, free or not, needs to be produced somewhere

- BCDEF don't specify *who* produces free digital service but the implied producer is social media/software firm
- Financing via advertisements or data sales
- Facebook's measured value-added = income generated in the advertising or data sales business
- Problem: measured value-added \neq shadow price * #of users



25\$ vs 500\$

- Facebook (2017)
- 25\$/user/year (approximative advertising revenues) < 500\$/user/year (willingness to forego)
 - (i) Facebook does not act as a profit maximiser (unlikely),
 - (ii) BCDEF findings are vastly overstated (implausible),
 - (iii) the value measured by BCDEF relates to a *different* act of production and consumption, *not* to the implicit barter transaction between consumers and Facebook.





Own-account HH production

- Production process by households who use:
 - time
 - capital services (hardware, software) including freely provided
- to produce (typically, leisure) services associated with the use of social media
- Neither their prices nor quantities need to coincide with the advertising or data sales values of digital service provider
- The latter are inputs to, the former are outputs of household production



Photo by David Boca on Unsplash



Own-account HH production

- Differences between valuation of services by consumers and revenues registered by Facebook can be fully and consistently accommodated
- HH own account production is today outside the SNA production boundary

$$q_F = F(K_F, t_F, Z)$$

q_F : quantity of own-account services

K_F : capital services input, including digital services

Z : size of network



Photo by David Boca on Unsplash



Cost function

$$c(q_F, u_F, w_F, Z) = \min_{K_F, t_F} [u_F K_F + w_F t_F : F(K_F, t_F, Z) \geq q_F]$$

u_F : user cost of capital services

w_F : implicit wage rate

$$p_F \equiv c^F(u_F, w_F, Z).$$

p_F : unit cost of own-account services



Photo by David Boca on Unsplash



Price index

$$\begin{aligned}\text{Willingness to forego} &= c(q_F, u_F, w_F, Z) - c(0, u_F, w_F, Z) \\ &= q_F c^F(u_F, w_F, Z) = p_F q_F\end{aligned}$$

Price index, quality adjusted for network size



$$P_F(u_F^1, w_F^1, Z^1, u_F^0, w_F^0, Z^0) = \frac{c^F(u_F^1, w_F^1, Z^1)}{c^F(u_F^0, w_F^0, Z^0)}$$



Törnqvist

$$\begin{aligned} & \ln P_F^T(u_F^1, w_F^1, Z^1, K_F^1, t_F^1, u_F^0, w_F^0, Z^0, K_F^0, t_F^0) \\ &= 0.5 \left(\frac{u_F^0 K_F^0}{u_F^0 K_F^0 + w_F^0 t_F^0} + \frac{u_F^1 K_F^1}{u_F^1 K_F^1 + w_F^1 t_F^1} \right) \ln \left(\frac{u_F^1}{u_F^0} \right) \\ &+ 0.5 \left(\frac{w_F^0 t_F^0}{u_F^0 K_F^0 + w_F^0 t_F^0} + \frac{w_F^1 t_F^1}{u_F^1 K_F^1 + w_F^1 t_F^1} \right) \ln \left(\frac{w_F^1}{w_F^0} \right) \\ &+ 0.5 \left(\frac{\partial \ln c^F(u_F^0, t_F^0, Z^0)}{\partial \ln Z} + \frac{\partial \ln c^F(u_F^1, t_F^1, Z^1)}{\partial \ln Z} \right) \ln \left(\frac{Z^1}{Z^0} \right) \end{aligned}$$



$$-\epsilon \equiv \frac{\partial \ln c^F(u_F^1, t_F^{*1}, Z^1)}{\partial \ln Z} \leq 0$$

Not observable,
4 simulations



Extended Measure of Activity



Extended Measure of Activity

Nominal GDP

$$Y^t = \sum_{i=1}^N p_i^t q_i^t.$$

Nominal EMA

$$\tilde{Y}^t = p^t \cdot q^t + p_F^t q_F^t.$$

GDP deflator

$$\ln P(p^1, p^0, q^1, q^0) = 0.5 \sum_{i=1}^N \left(\frac{p_i^1 q_i^1}{p^1 \cdot q^1} + \frac{p_i^0 q_i^0}{p^0 \cdot q^0} \right) \ln \left(\frac{p_i^1}{p_i^0} \right)$$

EMA deflator

$$\begin{aligned} & \ln \tilde{P}(p^1, p^0, p_F^1, p_F^0, q_F^1, q_F^0, q^1, q^0) \\ &= 0.5 \sum_{i=1}^N \left(\frac{p_i^1 q_i^1}{p^1 \cdot q^1 + p_F^1 q_F^1} + \frac{p_i^0 q_i^0}{p^0 \cdot q^0 + p_F^0 q_F^0} \right) \ln \left(\frac{p_i^1}{p_i^0} \right) \\ &+ 0.5 \left(\frac{p_F^1 q_F^1}{p^1 \cdot q^1 + p_F^1 q_F^1} + \frac{p_F^0 q_F^0}{p^0 \cdot q^0 + p_F^0 q_F^0} \right) \ln \left(\frac{p_F^1}{p_F^0} \right) \end{aligned}$$



EMA – GDP comparison

% difference in nominal levels EMA – GDP:

$$\frac{\tilde{Y}^t - Y^t}{Y^t}$$

% point difference in real growth rates
EMA – GDP:

$$= \ln \frac{\tilde{Y}^1}{\tilde{Y}^0} - \ln \frac{Y^1}{Y^0} - (\ln \tilde{P} - \ln P)$$





Implied value of leisure time



Variable		Unit	Acronym	Year	
				2004	2017
Time spent on Facebook	1	Minutes per day		20	40
	2	Hours/year	t_F	122	243
WTA (BCDEF[7])	3	\$/year		—	506
User costs					
—all ICT capital services	4	\$/hour		0.01	0.03
—Facebook ICT capital services	5=4*2	\$/year	$u_F K_F$	1.46	6.58
Implied wage rate	6	\$/hour	w_F	1.58	2.05
Value of leisure time per person	7=6*2	\$/year	$w_F t_F$	192	499
Value of leisure services per person	8=7+5	\$/year	$p_F q_F$	194	506

- Avoids complications of time valuation (Diewert, Fox and Schreyer 2017)



Unit cost index for leisure services



Variable		Unit	Acronym	Year	
				2004	2017
Change of wage rate for leisure services		Index	w_F^1/w_F^0	1.00	1.30
Price change of ICT capital services		Index	u_K^1/u_K^0	1.00	0.3604
U.S. Facebook users		Million persons	Z	0.10	200
Törnqvist unit cost index of leisure services		Index	P_F^1/P_F^0		
—no quality adjustment	$\epsilon = 0$			1.000	1.2493364
—quality adjustment	$\epsilon = 0.5$			1.000	0.0279360
—quality adjustment	$\epsilon = 1.0$			1.000	0.0006247
—quality adjustment	$\epsilon = 1.5$			1.000	0.0000140



EMA - GDP comparison



Real GDP		Index	$(Y^1/Y^0)/(P^1/P^0)$	1.000	1.265
		% change per year	$\ln(Y^1/Y^0) - \ln(P^1/P^0)$		1.81
Real Extended Measure of Activity		Index	$(\tilde{Y}^1/\tilde{Y}^0)/(\tilde{P}^1/\tilde{P}^0)$		
—no quality adjustment	$\epsilon = 0$			1.000	1.260
—quality adjustment	$\epsilon = 0.5$			1.000	1.272
—quality adjustment	$\epsilon = 1.0$			1.000	1.285
—quality adjustment	$\epsilon = 1.5$			1.000	1.297
Real Extended Measure of Activity		% change per year	$\ln(\tilde{Y}^1/\tilde{Y}^0) - \ln(\tilde{P}^1/\tilde{P}^0)$		
—no quality adjustment	$\epsilon = 0$				1.77
—quality adjustment	$\epsilon = 0.5$				1.85
—quality adjustment	$\epsilon = 1.0$				1.93
—quality adjustment	$\epsilon = 1.5$				2.00
Difference: Real Extended Measure of Activity minus Real GDP		% point per year	$\ln(\tilde{Y}^1/\tilde{Y}^0) - \ln(Y^1/Y^0) - [\ln(\tilde{P}^1/\tilde{P}^0) - \ln(P^1/P^0)]$		
—no quality adjustment	$\epsilon = 0$				-0.04
—quality adjustment	$\epsilon = 0.5$				0.04
—quality adjustment	$\epsilon = 1.0$				0.12
—quality adjustment	$\epsilon = 1.5$				0.19

Labour productivity



Variable		Unit	Year	
			2004	2017
Real GDP		%/year		1.81
Hours worked		%/year		0.64
Labour productivity based on GDP and official hours worked		%/year		1.17
Real Extended Measure of Activity				
—no quality adjustment	$\epsilon = 0$	%/year		1.77
—quality adjustment	$\epsilon = 0.5$	%/year		1.85
—quality adjustment	$\epsilon = 1.0$	%/year		1.93
—quality adjustment	$\epsilon = 1.5$	%/year		2.00
Hours worked				
—as measured		Million	249065	270679
—in Facebook-enabled leisure production		Million	12	48667
Total		Million	249077	319345
		%/year		1.91
Labour productivity based on EMA				
—no quality adjustment	$\epsilon = 0$	%/year		-0.14
—quality adjustment	$\epsilon = 0.5$	%/year		-0.06
—quality adjustment	$\epsilon = 1.0$	%/year		0.01
—quality adjustment	$\epsilon = 1.5$	%/year		0.09



Discussion and conclusions



What has been achieved

- Consistent treatment of user valuations that deviate from market revenues by the corporations that provide free services
- Unit costs of own-account production and consumption are conceptually clearly identified
- Network effects as quality adjustment to unit costs but elasticity remains to be estimated
- Macro-effects are visible *as per* EMA





Ok for EMA – but also for GDP?

- *Type 3* household production (leisure) before *type 2* (cooking a meal, home care) inside the production boundary?
- Robustness of estimates
- Communication and trust in statistics
 - higher level of imputed consumption and income and lower inflation don't match perceptions
 - Central Banks – happy with EMA?
 - the end of unemployment?



2016 ALZHEIMER'S
DISEASE FACTS AND
FIGURES



In summary then



- HH activities gain in importance in modern societies as a consequence of digitalisation and demographic developments
- Research into their measurement is important and needs encouragement
- From there to bringing them inside GDP is still a long way however
- Key = interaction with stakeholders



Thank you!



Paul.Schreyer@oecd.org