UNSW Business School

## Centre for Applied Economic Research

# Experimental Economics and the New Commodities Problem


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# Summary

- **Brynjolfsson, Collis, Diewert, Eggers and Fox (2019) have used experimental economics to measure the welfare benefits of free (digital) commodities and to define an extended measure of output, GDP-B.**

- **Adapt their methodological approach to new commodities which may or may not be free.**

- **Provide a new method for estimating Hicksian reservation prices, the prices that reduced demand to zero in the period before they existed.**

- **Show that the Total Income Approach to GDP-B is (approximately) the difference between a true index and measured GDP.**

# The Paper in Two Figures: $q_1$=regular good, z=new good; $w^R$=reservation price

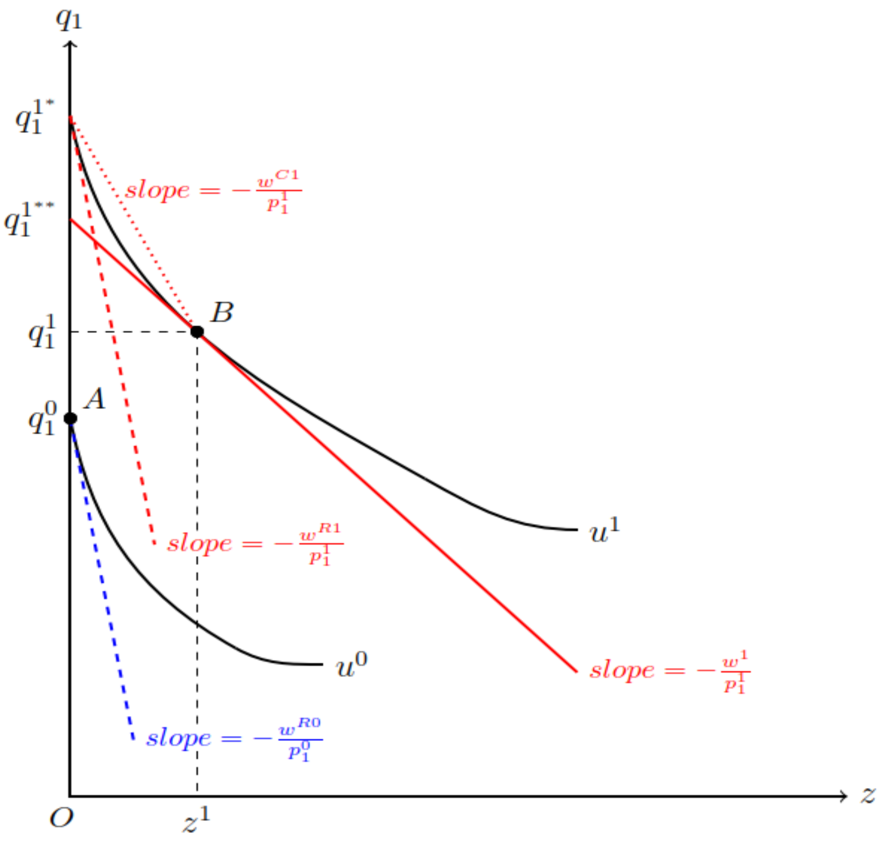


Figure 1: The Two Commodity Case, when $w^1 > 0$

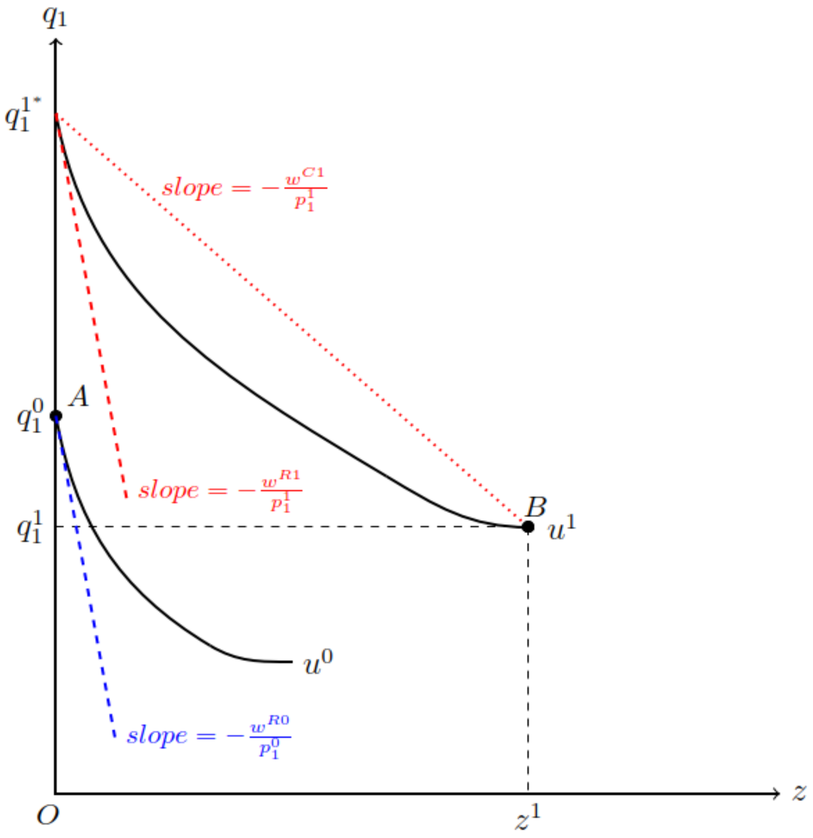


Figure 2: The Two Commodity Case, when $w^1 = 0$

## The Paper in Two Figures: $q^1$=regular good, z=new good; $w^R$=reservation price

**Utility function is homogeneous of degree 1. Hence:**

$$-w^{R1}/p_1^{\,1} = -w^{R0}/p_1^{\,0}$$

**and we can solve for the new commodity's reservation price in period 0:**

$$w^{R0} = w^{R1}/[p_1^{\,1}/p_1^{\,0}] \;;$$

**The period 0 reservation price is the inflation adjusted *carry backward* period 1 reservation price. That is, deflated by the inflation of the continuing, regular commodity.**

**⇒ if we have an estimate of $w^{R1}$ from e.g. BCDEF-style Willingness-to-Accept experiments, then we have $w^{R0}$.**

# Some Theory

What is the income required for the household to achieve the utility level $u^1$, excluding the use of the new commodity?

$$c(u^1,p^1,0) \equiv \min_q \{p^1 \cdot q : f(q,0) = u^1\} > c(u^1,p^1,z^1) = p^1 \cdot q^1$$

Define the monetary compensation $m^1$ that is additional to $p^1 \cdot q^1$ that is required to keep the household at the utility level $u^1$ without using $z^1$ as follows:

$$m^1 \equiv c(u^1,p^1,0) - p^1 \cdot q^1$$

# Some Theory

We convert $m^1$ into a period 1 ***average compensation price per unit of z foregone*** by setting $m^1$ equal to $w^{C1}z^1$:

$$w^{C1} \equiv m^1/z^1$$

Recall the two figures from earlier….

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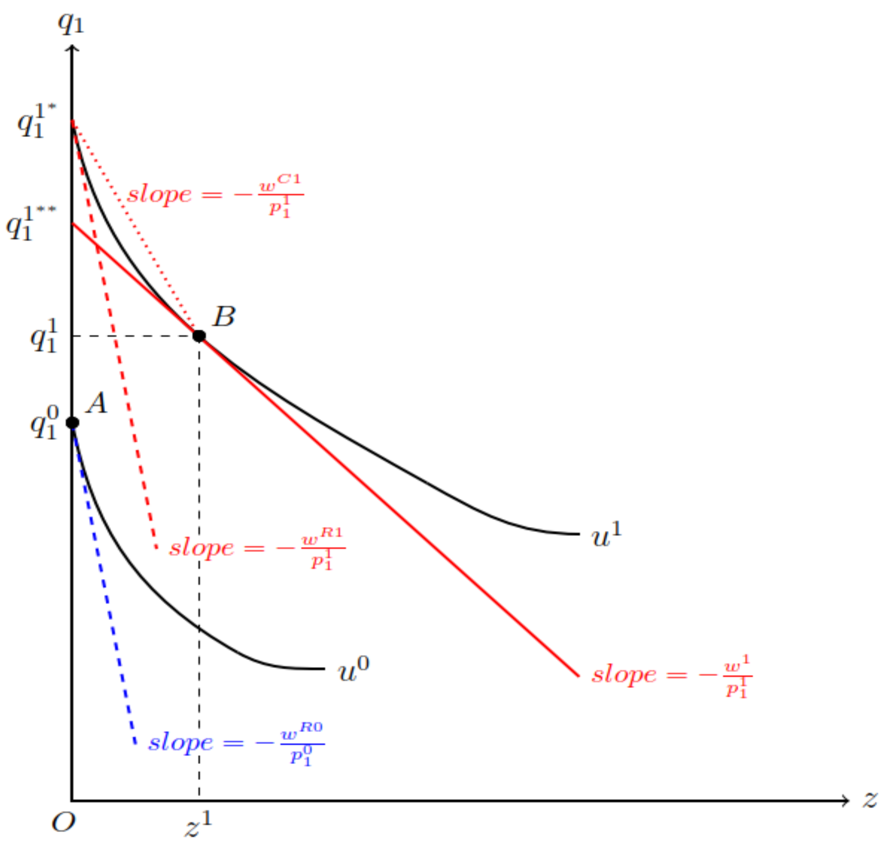


Figure 1: The Two Commodity Case, when $w^1 > 0$

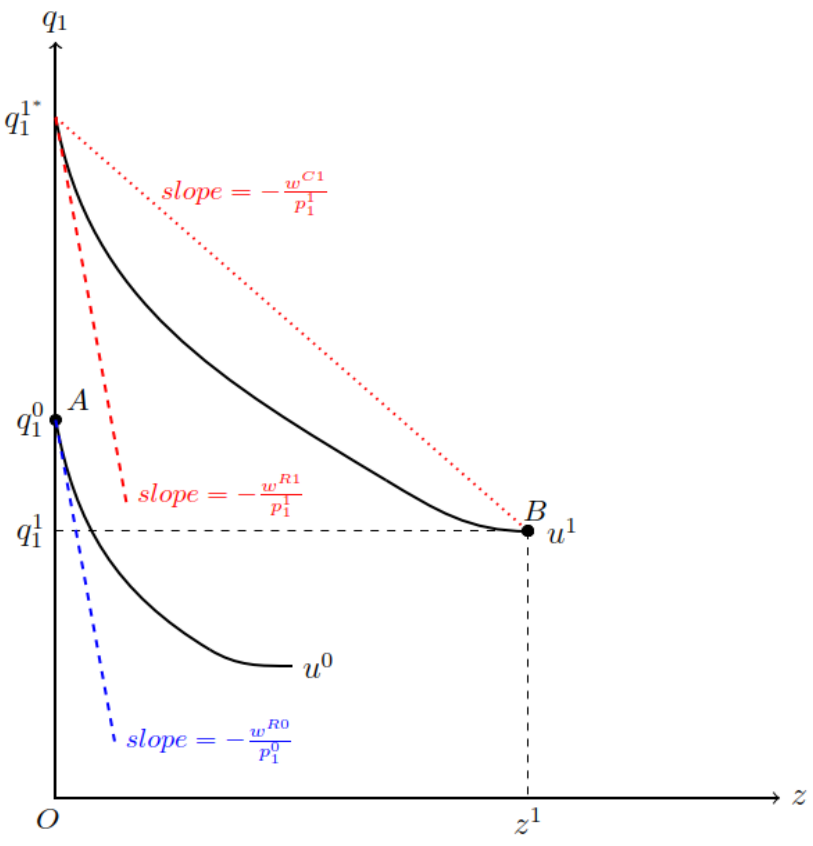


Figure 2: The Two Commodity Case, when $w^1 = 0$

# Some Theory

First-order Taylor series approximations:

$c(u^1,p^1,0) \approx c(u^1,p^1,z^1) + [\partial c(u^1,p^1,z^1)/\partial z][0 - z^1] = c(u^1,p^1,z^1) + w^1 z^1.$

$\Rightarrow \; c(u^1,p^1,0) - c(u^1,p^1,z^1) \approx w^1 z^1$

$c(u^1,p^1,z^1) \approx c(u^1,p^1,0) + [\partial c(u^1,p^1,0)/\partial z][z^1 - 0] = c(u^1,p^1,0) - w^{R1} z^1,$

$\Rightarrow \; c(u^1,p^1,0) - c(u^1,p^1,z^1) \approx w^{R1} z^1$

Arithmetic average of the two first order approximations:

$c(u^1,p^1,0) - c(u^1,p^1,z^1) \approx ½(w^1 + w^{R1})z^1$

# Some Theory

$c(u^1,p^1,0) - c(u^1,p^1,z^1) = m^1 = w^{C1}z^1 \approx \frac{1}{2}(w^1 + w^{R1})z^1$.

Can solve for the unknown reservation price $w^{R1}$.

$$w^{R1} \approx 2w^{C1} - w^1$$

Recall that $w^1$ is the observed market price for $z^1$ and $w^{C1}$ is the period 1 compensation price per unit of z foregone, as elicited from experimental evidence.

If z is free, then $w^1 = 0$ and $w^{R1} \approx 2w^{C1}$.

# Note

- It is unclear how good this approximation would be for truly novel products.
  - BCDEF (2018) argue that a reservation price of twice the per unit compensation price is too low, at least for innovative digital products with few substitutes.

- If q and z are perfect substitutes, then the indifference curves are linear:
  - Then the reservation price $w^{R1}$, the observed price $w^1$ and the average compensation price $w^{C1}$ are all equal.

# What About GDP?

NSOs use ***maximum overlap*** price indexes (using only continuing goods) to deflate nominal value growth. Then the maximum overlap quantity index is:

$$Q_{MO} \equiv \{[p_1^1 q_1^1 + w^1 z^1]/[p_1^0 q_1^0]\}/[p_1^1/p_1^0]$$

$$= [q_1^1 + (w^1/p_1^1)z^1]/q_1^0.$$

**Laspeyres and Paasche "true" real indexes**, $Q_L$ and $Q_p$ respectively:

$$Q_L \equiv [p_1^0 q_1^1 + w^{R0} z^1]/[p_1^0 q_1^0 + w^{R0} 0] = [q_1^1 + (w^{R0}/p_1^0)z^1]/q_1^0 \; ;$$

$$Q_P \equiv [p_1^1 q_1^1 + w^1 z^1]/[p_1^1 q_1^0 + w^1 0] \quad = [q_1^1 + (w^1/p_1^1)z^1]/q_1^0 \; .$$

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# What About GDP?

**Approximate “true” Fisher quantity index:**

$$Q_F \approx \tfrac{1}{2}Q_L + \tfrac{1}{2}Q_P$$

$$= [q_1^1 + \tfrac{1}{2}(w^{R1}/p_1^1)z^1 + \tfrac{1}{2}(w^1/p_1^1)z^1]/q_1^0$$

$$Q_F - Q_{MO} \approx [(w^{C1} - w^1)z^1/(p_1^1/p_1^0)]/p_1^0 q_1^0$$

**If $w^1 = 0$:**

$$Q_F - Q_{MO} \approx [m^1/(p_1^1/p_1^0)]/p_1^0 q_1^0$$

# Note

- Actually derived for the one continuing good case. Can easily generalise to multiple goods: only change in the above expressions is that $p_1{}^0 q_1{}^0$ becomes $p^0 \cdot q^0$.
- This is exactly the adjustment to GDP growth from the GDP-B Total Income Approach of BCEDF (2019).
- Thus if the approximation $w^{R1} \approx 2w^{C1} - w^1$, is a good one then **the difference between the Total Income quantity index and the maximum overlap quantity index can be interpreted as the amount by which a maximum overlap index understates an approximate "true" Fisher index.**

# Summary

- **Adapted the BCDEF (2019) approach to measure the benefits of new commodities which may or may not be free.**

- **Provided a new method for estimating Hicksian reservation prices, the prices that reduced demand to zero in the period before they existed.**

- **Showed that the BCDEF Total Income Approach to GDP-B is (approximately) the difference between a true index and measured GDP.**

# Reference

**Brynjolfsson, E., A. Collis, W.E. Diewert, F. Eggers and K.J. Fox (2019), "GDP-B: Accounting for the Value of New and Free Goods in the Digital Economy", NBER Working Paper 25695.**
https://www.nber.org/papers/w25695