The Value of Cultured Meat: An Estimate of the Externality Costs of Meat Consumption

Nathan Fiala

Summary
Using FAO estimates of the greenhouse gas (GHG) emissions from meat production and a range of published cost estimates for these emissions, we find that the global environmental costs of meat consumption are more than $140 billion per year, totaling between $4 trillion and $15 trillion from 2010 to 2040. The estimates are conservative, as they do not include the projected increase in meat consumption. Using published estimates of the GHG emissions from cultured meat, we find that global cost savings of replacing meat would be more than $130 billion per year.

Introduction
This short note calculates the social externality costs of meat consumption and the value to society from shifting to consumption of alternatives, such as cultured meat. The calculations are based on research conducted by numerous authors and are presented as ranges in order to capture intrinsic uncertainties.

This note focuses on the environmental externalities. In addition, there are also health-related externality costs, which include both individual health impacts and infectious diseases. Barnard et al. (1995) have calculated the individual health costs, in the form of increased rates of heart disease, cancer, etc., as between $30 billion and $60 billion dollars per year for the US, a number comparable to smoking. US consumption of meat is approximately 10% of the total world, suggesting that the world cost is significantly higher. How much higher though is not clear.

In addition to individual health costs, there are also significant economic costs to E. coli and Salmonella contamination, as well as Mad Cow Disease and H1N1. The numbers presented below are thus a minimum amount.

Environmental Externalities
The 2007 FAO report, *Livestock's Long Shadow*, puts the total greenhouse gases from worldwide livestock production at 4.6 billion metric tonnes of equivalent carbon dioxide (CO2). This amount is calculated by converting methane and other waste products into CO2 equivalent numbers. The conversion for methane is 23 times the effect of CO2 over 100 years. However, this time horizon may not be relevant for most policy decisions regarding climate change (IPCC 2007).

The relevant time horizon is most likely closer to 20 years, over which the greenhouse effect of methane is 64 times that of CO2[1]. This increases the effect of methane and in turn puts the greenhouse gas estimates of the FAO at 8.4 billion metric tonnes of equivalent CO2.

The estimates presented below start in 2010 and continue to 2040. Over this time period, consumption will substantially increase for some meat products, such as chicken and pig products, while others, such as beef products, are likely to increase at a moderate rate (Fiala 2008). The marginal environmental impact of this increase will likely be small compared to the FAO baseline, since increased production is now largely occurring in factory farms with less deforestation. In fact, the FAO numbers are so large that they dwarf the likely marginal increase in consumption[2].

The calculations were performed as follows: I multiplied the FAO GHGs (4.6 billion tonnes for 100 year methane, 8.4 billion tonnes for 20 year) by the estimated cost of 1 tonne of GHGs, then summed across all years.

The low value assumes methane is treated in the standard 100-year time horizon. The high value assumes that methane is treated in a 20-year time horizon. In addition, I break out the environmental externality costs of meat consumption into two ranges of cost per tonne of CO2: a simple valuation, and an optimal tax valuation.

The costs of GHGs have been calculated by a number of researchers. The base range is between $20 and $40 (Nordhaus 2009) per tonne of CO2. I use the average, $30, as the simple base here. In addition, a number of researchers have estimated an optimal GHG tax rate These numbers range from $35 to more than $100. Following Nordhaus (2009), I use an increasing rate of $35 to $60 from 2010 to 2030.

The total environmental externality costs of meat consumption are presented in the following table, by decade:

Total costs (millions 2000 $)	2010	2010 - 2020	2010 - 2030	2010 - 2040
Simple low	$138,000	$1,380,000	$2,760,000	$4,140,000
Simple high	$252,000	$2,520,000	$5,040,000	$7,560,000
Nordhaus optimal low	$138,000	$1,591,140	$4,383,340	$8,271,720
Nordhaus optimal high	$252,000	$2,905,560	$8,004,360	$15,104,880

Meat consumption costs the world $140 billion plus per year, totaling between $4 trillion and $15 trillion from 2010 to 2040.

[1] Methane is a significantly stronger greenhouse gas than CO2, though over time it is changed into water and CO2 through chemical reactions in the atmosphere. The effect of methane is thus best understood as a comparison to CO2, averaged over its lifespan.

[2] See Fiala 2008 for an estimate of the impact of future consumption.

These results can then be compared to the environmental costs associated with producing cultured meat. Tuomisto1 and de Mattos (2009) calculate the environmental impact of cultured meat to be 1.4 kg of CO2 equivalent greenhouse gases for 1 kg of culturally produced meat. As of 2010, total world consumption of all meat products was approximately 209 billion kgs. Thus, to produce this meat through a cultured process would have produced 292 million tonnes of CO2 equivalent. The environmental savings of producing meat culturally is reflected in the following table:

Total savings (millions 2000 $)	2010	2010 - 2020	2010 - 2030	2010 - 2040
Simple low	$129,240	$1,292,400	$2,584,800	$3,877,200
Simple high	$243,240	$2,432,400	$4,864,800	$7,297,200
Nordhaus optimal low	$129,240	$1,490,137	$4,105,093	$7,746,646
Nordhaus optimal high	$243,240	$2,804,557	$7,726,113	$14,579,806

Producing meat through a cultured process thus produces significantly less GHGs (at least 90% less) and can produce significant cost savings.

References

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