Engel's What? A Response to Gan and Vernon

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Gan and Vernon's comment does not resolve the puzzle that we originally posed.

Their description of the puzzle is unclear, so we start by restating it. The essence of the matter is this. Imagine two households, one of which is larger than the other, for example, containing the same age and sex composition of people, but with twice as many of everyone. Imagine too that both households have the same level of per capita total household expenditure so that, in the example, the household with twice as many people spends twice as much in total. If there are economies of scale, the second household is better off. While it is possible for it to maintain exactly the same expenditure pattern as the smaller household, with everyone having the same of everything, it can also rearrange its purchases to take advantage of the differential economies of scale in different goods. Because food is a normal good, we would expect the larger household to spend more per capita on food. This is especially so in poor countries, where there are few substitutes for food, so that there is limited opportunity for substituting away from food toward goods with greater economies of scale. The evidence contradicts this prediction. We looked at household survey data from the United States, the United Kingdom, France, Taiwan, Thailand, Pakistan, and South Africa. In all cases, and with per capita expenditures held constant, larger households have *lower* per capita food consumption, and the reduction with household size is *greatest* in the *poorest* countries.

What do Gan and Vernon do? They show that, for the United States, Russia, and South Africa, when they increase household size holding constant per capita total expenditure, the per capita demand for *housing* falls more rapidly than the per capita demand for food. The same is also true for various combinations of housing and other goods, compared with food alone or food combined with clothing. This is correct, and such results can be inferred from table 5 (p. 920) of our original paper. But these findings do not address the central puzzle, which is that larger households that are (more than) fully compensated for their

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size, and that should be able to improve their welfare by taking advantage of economies of scale, have *lower* per capita food expenditure.

A convenient analytical tool for thinking about these issues was proposed by Barten (1964), who constructed an analogy between the effects of household composition on household demands and the effects of prices. Testing the Barten model was not our main concern, and indeed it has been known for many years that there are features of the model that are unrealistic (see, e.g., Gorman 1976; Deaton and Muellbauer 1980, p. 201). Even so, the Barten model yields a useful condition under which the partial derivative of the demand for food with respect to household scale (more people with composition and per capita expenditure held constant) will be positive, our equation (6). This equation shows that our empirical findings are consistent with Barten's model if there are large enough economies of scale in food consumption or if the compensated price elasticity of food is sufficiently large (in absolute value), so that the fall in food consumption can be attributed, at least in part, to substitution away from food toward other goods whose greater economies of scale make them effectively cheaper.

We considered these explanations in our paper and found them implausible, either separately or in combination. Gan and Vernon focus on the possibility that there are substantial economies of scale in food consumption, which, if true, would certainly help resolve the puzzle. But they generate no empirical evidence to support their contention that food has greater economies of scale than clothing or transportation. Their results quoted above provide no such evidence. More serious is Gan and Vernon's discussion of the economies of scale in food preparation. The existence of such effects is plausible, but they cannot explain the puzzle. The cost of the time spent in food preparation is *not* included in food expenditures in the data (nor should it be), so that the reduction in preparation costs per person that comes with larger household size will result in an *increase* in food expenditures per head. In consequence, far from resolving the puzzle, food preparation costs deepen it. The discussion on page 922 of our original paper deals with precisely this issue.

Gan and Vernon make a number of statements that require rebuttal. We do not assume that preferences are the same in all countries. Nor can we reproduce their derivation (their eq. [5]) of our proposition that the effect of household scale on food consumption be larger in poorer countries. Nor do we believe that there are only two goods in the world, and we do not, as Gan and Vernon claim, define housing as total expenditures other than food. In consequence, it is not true that our empirical tests depend on the relative economies of scale of food and housing. However, our use of the composite commodity theorem to aggregate nonfood is perhaps uncomfortably close to the two-good

assumption. But not surprisingly, our key results are readily generalized to the case of multiple nonfoods. Our inequality (4) uses the Barten model to give a relationship between economies of scale and price and income elasticities, which, if true, would resolve the puzzle. Specifically, per capita food consumption *falls* with household size if

$$\sigma_h(\epsilon_{fx} + \epsilon_{ff}) - \sigma_f(1 + \epsilon_{ff}) < 0, \tag{1}$$

where ϵ_{ff} and ϵ_{fx} are the (uncompensated) price and total expenditure elasticities of food, and σ_f and σ_h are the measures of economies of scale in food and nonfood. This inequality shows, for example, that the puzzle is consistent with the model if food has a high enough price elasticity or if there are large enough economies of scale in food consumption. When there are multiple nonfoods, the inequality (1) holds with only minimal modification. In particular, if we define $\bar{\sigma}$ as the budget share weighted average of the economies of scale parameters for all nonfoods, equation (1) can be replaced by

$$\bar{\sigma}(\epsilon_{fx} + \epsilon_{ff}) - \sigma_f(1 + \epsilon_{ff}) < \sum_{k \neq f} \tilde{\epsilon}_{fk}(\sigma_k - \bar{\sigma}), \tag{2}$$

where $\tilde{\epsilon}_{fk}$ is the compensated elasticity of the demand for food with respect to the price of good k. This last term, which can be positive or negative, captures the net spillover effect on the demand for food of substitution-based rearrangements among nonfoods in response to an increase in household size. It is hard to think of this term as providing a resolution of the puzzle, and indeed, Gan and Vernon's arguments do not take this direction.

A final issue concerns Gan and Vernon's discussion of Engel's law and of Engel's method for measuring the extent of economies of scale. Their comment does not make a sufficiently clear distinction between Engel's first law (usually referred to as "Engel's law") and Engel's second law. Engel's law, first observed empirically by Engel and as understood in the economics literature for nearly 150 years, says that there is an inverse relationship between the food share and total household expenditure, or sometimes income. Engel himself, in a paper written many years after his empirical work on Engel's law, *claimed* that the food share was indeed an inverse indicator of welfare across households of different sizes and compositions. This assertion, which is sometimes referred to as Engel's *second* law, can be used to derive compensating variations by calculating, for a household of any particular composition, the amount of income or total expenditure that would be required to equate its food share with that of a reference household.

Many years ago, Nicholson (1976) showed that Engel's second law makes no sense for calculating the costs of children. Suppose that a previously childless couple has a new child and is fully compensated for

the monetary costs by an all-seeing family court judge who is assumed to know the answer to the equivalence scale problem. Because the child needs a lot of food relative to other goods, the fully compensated household will have a *higher* share of food, which contradicts Engel's assertion. Our own treatment of economies of scale provides a related argument in this case. In the presence of economies of scale, a larger household with the same per capita income has been *overcompensated* compared with a smaller one. If food is a normal good (and there are few economies of scale in food and limited possibilities of substitution away from it), the per capita demand for food will rise. Because per capita total expenditure is being held constant, the budget share of food (per capita food expenditure divided by per capita total expenditure) will rise. This contradicts Engel's assertion, and indeed, this contradiction is at the heart of our paper. Nowhere in our paper do we cast doubt on Engel's law itself.

References

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