Nutrition and productivity

Abhijit Banerjee

Department of Economics, M.I.T.
1 A simple theory of nutrition and productivity

The capacity curve (fig 1)

- The capacity curve: It relates income and work capacity (productivity)
  - Higher income $\rightarrow$ better nutrition.
  - Better nutrition: first used by the body for the basic metabolism. Then only it translates in higher capacity.
  - As a result, the work capacity is convex, and it intersects the 45 degree line from below.
The Piece-wage schedule (fig 2)

- The piece wage schedule
  - The amount of income you get for each task you perform
  - \( v_1 > v^* > v^3 \)
  - There is a wage \( v^* \) at which the body "breaks even" \( \rightarrow \) it creates a discontinuity in the labor supply.

Discontinuous labor supply (fig 3)

- The individual labor supply jumps

- We can now draw the \textit{aggregate} labor supply.
Equilibrium (fig 3)

- Introduce a *labor demand* curve.

- What happens if the labor supply cross the labor demand in the gap?

- There is *involuntary unemployment*
  Definition= A person is involuntarily unemployed if he cannot find employment in a market which does employ a person very similar to him and if the latter person, by virtue of his employment in this market is distinctly better off than him.

- The vicious circle is complete: low wage leads to reduced work capacity, which closes access to employment.
1.1 The effect of non-labor income (fig 4)

- In what direction do assets move the capacity curve?

- Who is more likely to be employed: the rich or the poor?

- Who earns a larger wage income if both are employed?

The vicious circle of inequality: the functioning of the labor market magnifies assets inequality.
1.2 The effect of redistributing wealth

- Imagine individuals are ranked by land holding (fig 5)

- $m$ have no land.
Who will work (fig 6)

Definition: Minimum wage such that an individual can or want to work.

• Capacity curve and labor supply.
  – what is the minimum wage at which someone can work?
  – Labor supply for capacity to work: the minimum wage necessary decreases with wealth

• Willingness to work and labor supply
  – The willingness to work is smaller for richer people
  – Labor supply for willingness to work: the minimum wage necessary increases with wealth.
Labor Supply (fig 7)

• Combine the two: labor supply.

• How does redistributing land from the rich to the poor affect labor supply

• What happens to wages, production.
1.3 Dynamics

• Assume now that work capacity today is a function of last period’s nutrition:

\[ \text{workcapacity}_t = f(n_{t-1}), \quad f' > 0 \]

• To simplify the analysis, let us assume away all the labor market issues—everyone works on his own and gets an income equal to his work capacity. Furthermore nutrition is an increasing function of income.

• Therefore

\[ n_t = g(\text{workcapacity}_t) = g(f(n_{t-1})). \]
Implications

- Poverty trap (fig 10).

- Reinforces the lack of a equity-efficiency trade-off

- What if poor people could enter into long term employment contracts?

- What would be the effect of providing free meals?

- What would be the effect of providing access to credit?

- What would be the effect of an employment guarantee scheme?

- How much does an improvement in a household’s income increase investments in human capital?
1.4 Looking at the evidence

• Observe that the model, in order to generate a poverty trap, requires that over a range, the $f(g(\cdot))$ curve intersects the 45 degree line from below.

• A poverty trap will emerge if $f'g' > 1$. Let’s denote income by $y$ and do some algebra:

$$f'g' = g f' \times \frac{g'}{g} = \frac{f'}{f} g \times \frac{g'}{g} y \times \frac{f}{y}$$

(1)

The expressions $\frac{f'}{f}g$ and $\frac{g'}{g}y$ are called “elasticities”.

• On the 45 degree line, $f = y$. Expression 1 tells us that there can be a nutrition-based poverty trap only if the product of the elasticities of the income-nutrition and nutrition-productivity relationships is greater than 1. It gives us a clear empirical fact to look for.
1.5 A Methodological aside: investigating the relationship between two variables

- Say we are interested in the relationship between log(income) and log(calories).

- We start with a data set (say, data from India), which will look like two columns (two variables), with one observation of income and one observation of log(calories) for a sample of individuals (for example: 200 individuals).

- The first thing we could do: plot the data. We put log(income) on the x axis and log(calories) on the y axis.
• Suppose we want to summarize the shape of this graph:

• The most flexible way is the “non-parametric regression”: we try to trace the function \( g(.) \) which best captures the variation in the data. We want to find \( g \) such that

\[
\text{ln(calories)} = \hat{g}(\text{ln(income)}) + \hat{\epsilon}
\]

Where \( E(\hat{\epsilon}) = 0 \). \( \hat{\epsilon} \) is called the residual of our regression. \( \hat{g}(\text{ln(income)}) \) is the predicted value of \( \text{ln(calories)} \)

• We are not going to go into the details of how we find this function \( \hat{g}(.) \). There are several methods, of which the “kernel” regression is the most commonly used.
• The most economical form is to run a linear regression: we restrict the function \( \hat{g}(.) \) to be a linear function of \( \log(\text{expenditure per capita}) \). That is, we try to find the line that represent the best the cloud of points.

\[
\ln(\text{calories}) = \hat{\beta} + \hat{\alpha} \ln(\text{income}) + \hat{\epsilon},
\]

where \( E(\hat{\epsilon}) = 0 \).
• Note that these are all just ways to describe the data.

• It is not because we have decided to run this particular regression that we have uncovered the true causal relationship between income and nutrition.

• For example, what would I find if I were to run a regression of the number of sick people on the number of doctor in an area? How should I interpret it?
• Often, we assume that the data has been generated by a model of the form:

\[
\ln(\text{calories}) = \beta + \alpha \ln(\text{income}) + \epsilon,
\]

where \( \epsilon \) is some error term, with \( E(\epsilon|\ln(\text{income})) = 0 \) and then, the linear regression will uncover our best estimates of \( \alpha \) and \( \beta \) (notice that the hats are gone above the parameters).

• In this case we assume that \( \log(\text{expenditures per capita}) \) causes \( \log(\text{calories per capita}) \). In this course, we will see many instances (for example today!) where this is not the right model to assume, and how to deal with that.
1.6 The relationship between income and nutrition: The “conventional wisdom” and its problems

- “Conventional wisdom”: more income leads to more income spent on food and to better nutrition. In the data: strong correlation between income and food expenditures.

- Note: if you regress food expenditures on total expenditures, the coefficient is less than one. What does the relationship between the share of expenditure spent on food and total expenditure?

- This is called *Engel’s law*: As household income increases, the share spent on food decreases.
Problems with figuring out how much income affects nutrition

1. Reverse causality

2. Common causes


   • Meals taken outside the household and given to people.
     - Who tends to eat out?
     - Who tends to feed people?
     - In what direction does that bias the relationship between income and actual nutrition if you do not observe meals taken out and given to people but only total expenditure on food?
4. Measurement problem (2)

- Food waste
  - Who tends to waste more?
  - In what direction does that bias the relationship between income and actual nutrition if you do not observe waste but only total expenditures on food?

5. Measurement problem (3):

- Even if expenditures were correctly measured, they do not give a correct representation of quality. As people get richer, they buy better tasting food.

- How does it bias $\alpha$?
1.7 Income and nutrients in Maharastra, India

Based on Deaton and Subramanian (JPE, 1996)

D-S deal with some measurement issues

- Meals taken in and given out. The data set includes the number of meals taken out, meals given to people, meals taken at home: they correct for this.

- Quality: They start with 149 food items that the households have consumed in the past 30 days. Items are very precise (ex: several categories of rice are included). They use a conversion table to calculate how many calories are provided by each item.

- Cannot fix Waste and Endogeneity
D-S take a Non-parametric approach  In addition, their work not only examines the average relationship, but also the entire shape of the relationship between income and nutrition: Do we observe the non-linearity which forms the basis of the Dasgupta-Ray model we studied in lecture 2?

To do so, they run *non-parametric regressions*:

\[
\ln(\text{calories}) = g(\ln(\text{expenditure})) + \epsilon
\]

They try to estimate the shape of the function \( g(.) \).
D-S Results:

- The relationship between expenditure and calories
  - Figure 2: More expenditures $\rightarrow$ better nutrition.
  - Figure 3: Elasticity: derivative of the curve in figure 2. It is declining with expenditures (the curve is concave), but not very fast.

- The relationship between quality and expenditures
  - An indicator of quality: price paid per calorie.
  - Figure 4: Log of price per calorie increases with expenditures.
  - Figure 5: Elasticity is fairly constant with expenditures.
1.8 Conclusion

• There is a fairly strong relationship.

• However there is also a lot of substitution towards quality even at low incomes.

• Not surprising given that they calculate that 2000 calories cost about 4% of the average daily wage.

• The elasticity is nowhere close to 1....
2 The relationship between nutrition and productivity

Is there evidence that this relationship is very steep?

• There is experimental evidence that better-fed workers are more productive at physical tasks. Example: 302 anemic rubber tree tapper in Indonesia. Half were allocated to a treatment group who was given iron supplement, half were allocated to a placebo. After 60 days, the treatment group had lower anemia, higher capacity, and higher productivity than the placebo group.
• In the early 1990s, the Indonesian government experimented with an increase in health care prices: they increased the prices in a set of (randomly chosen) pilot locations. The consequences were: people were less likely to participate in the labor market in the pilot areas. Those who participated earned less.

• However the elasticity of the productivity-nutrition relationship is below one... The product will not be above one: a study of the relationship between farm productivity and calorie consumption in Burkina Faso (Strauss 1986) finds an elasticity of 0.34, 0.49 for the poorest.
3 Conclusion: Should we abandon DasGupta and Ray?

- This exercise has shown us that this very clever and appealing model is not a literal description of the reality: the relationship between calories and nutrition is not steep enough to generate a poverty trap by itself: the product of the two elasticities is around 0.09, which is far from one!!

- However, the model forces us to think about how the nexus between human capital and income can lead to a vicious circle: this circle may be found in contexts other than the health and productivity nexus.

- Examples:
  - Child development
  - Schooling investment