Nutrition

1. Nutrition and Productivity

The Vicious Circle of Poverty and Undernutrition

- Recall the story of Abu mentioned in the Introduction.
  - as long as people are poor they will be sick and as long as they are sick they will be poor?

1.1 Theory: Dasgupta and Ray (1986)

- The theory is founded on the much-discussed observation that
  - at low levels of nutrition-intake there is a positive relation between a person's nutrition status and his ability to function;
    - a person's consumption-intake affects his productivity.
- The central idea is that unless an economy in the aggregate is richly endowed with physical assets, it is the assetless who are vulnerable in the *labour market*.
  - Potential employers find attractive those who enjoy non-wage income, for in effect they are cheaper workers.
  - Those who enjoy non-wage income can undercut those who do not, and
    - if the distribution of assets is highly unequal even competitive markets are incapable of absorbing the entire labour force:
      - the assetless are too expensive to employ in their entirety, as there are too many of them.

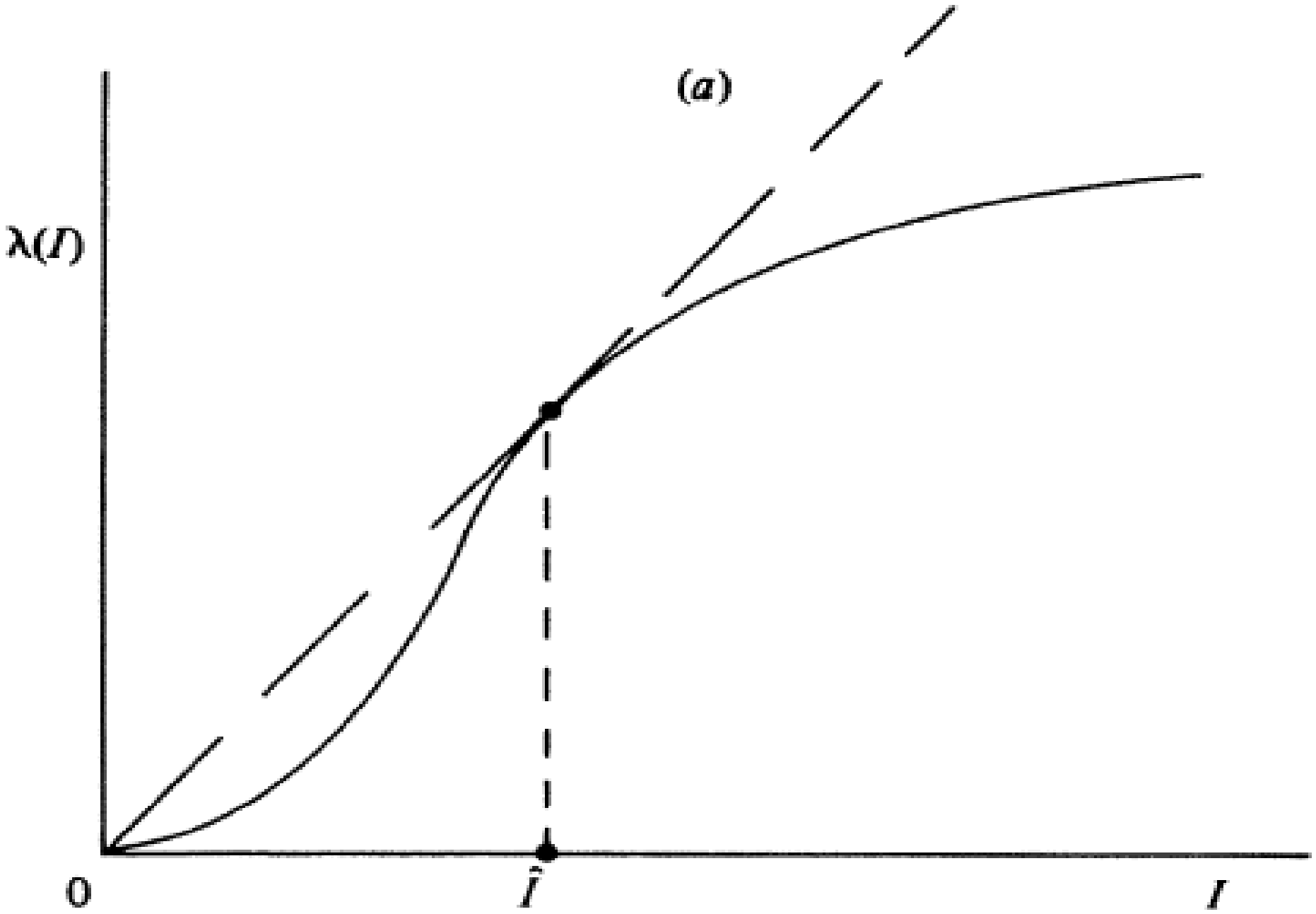
- A simple example:
  - Suppose each person requires precisely 2000 calories per day to be able to function;
    - anything less and his productivity is nil; anything more and his productivity is unaffected.
  - Consider two persons; one has no non-wage income while the other enjoys 1500 calories per day of such income.

$\Rightarrow$ The first person needs a full 2000 calories of wages per day in order to be employable; the latter only 500 calories per day.

  - It is for this reason the assetless is disadvantaged in the labour market.

1.1.1 The Model

- Consider a timeless construct and abstain from uncertainty.
- Distinguish labour-*time* from labour-*power*;
  - it is the latter which is an input in production.
- Denote by λ the labour-*power* a worker supplies over a fixed number of 'hours'.
  - Assume that λ is functionally related to the worker's consumption, I, as shown in Figure 1(a).
- The key features of the functional relationship are:
  - it is increasing in the region of interest;
  - at low consumption levels it increases at an *increasing* rate, followed eventually by diminishing returns to further consumption.


(a)
λ(I)
0
Î
I

- The reason for this work capacity - consumption relationship can be explained as follows.
  - Initially, most of the nutrition (consumption) goes to maintaining *resting metabolism*, and so sustaining the basic frame of the body.
    - In this stretch very little extra energy is left over for productive work.
    - Work capacity in this region is very low, and does not increase too quickly as nutrition levels change.
  - Once resting metabolism is taken care of, there is a marked increase in work capacity,
    - the lion's share of additional nutrition input can now be funneled to work.
  - This phase is followed by a phase of diminishing returns,
    - the natural limits imposed by the body's frame restrict the conversion of increasing nutrition into ever-increasing work capacity.

- An alternative specification of the work capacity - consumption relationship (used, for example, by Bliss and Stern (1978)) is drawn in Figure 1(b).
  - Work capacity or labour power, λ, is nil until a threshold level of consumption, I^*, the *resting metabolic rate* (RMR).
  - $\lambda(I)$ is an increasing function beyond I^*;
    - but it increases at a diminishing rate.

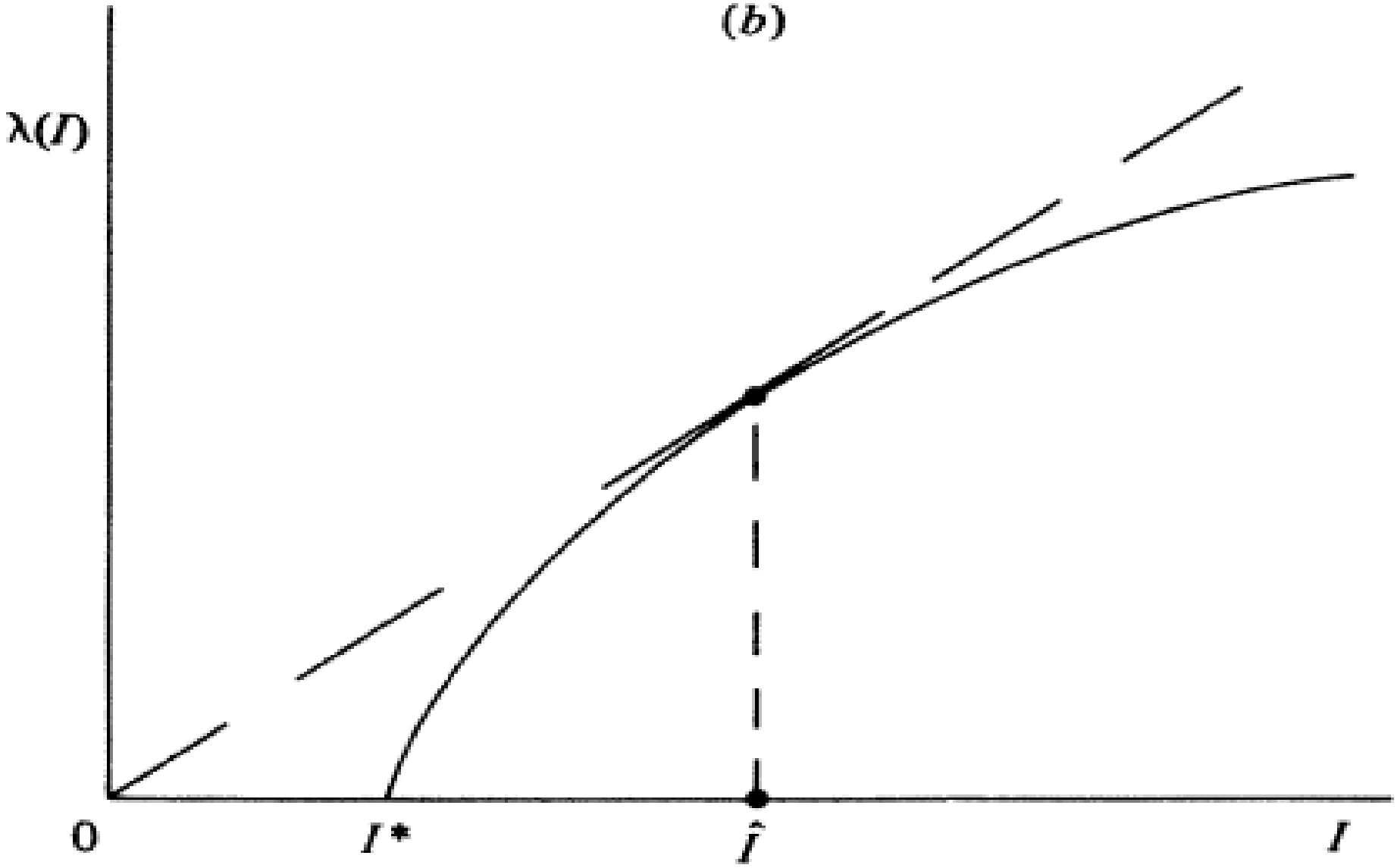


Fig. 1

- The aggregate production function is $F(E, T)$.
  - E denotes the aggregate labour-power employed in production;
    - It is the sum of individual labour powers employed.
  - T denotes the quantity of land.
  - Land is homogeneous; workers are not.
- $F(E, T)$ is assumed to be concave, twice differentiable, constant returns to scale, increasing in E and T, and displaying diminishing marginal products.
- Total land in the economy is fixed at $\hat{T}$.
- Aggregate labour power in the economy is endogenous.
- Total population, assumed to be equal to the potential labour force, is N; N is large.
  - Approximate and suppose that people can be numbered along the interval $[0, 1]$.

- Each person has a label, n, where n is a real number between 0 and 1.
- Population density is constant and equal to N.
  - Normalize $N = 1$, so as not to have to refer to the population size.
- The proportion of land an n-person owns is $t(n)$;

$\Rightarrow$ total amount of land he owns is $\hat{T}t(n)$.

  - We label people such that $t(n)$ is non-decreasing in n.
    - So $t(n)$ is the land distribution and is assumed to be continuous.
- In Figure 2 a typical land distribution is drawn.
  - All persons labelled 0 to $\underline{n}$ are landless.
  - From $\underline{n}$ the $t(n)$ function is increasing.

Fig. 2

- Assume one either does not work in production sector or works for one unit of time.
- There are competitive markets for both land and labour power; let r denote the competitive land rental rate. $\Rightarrow$ The n-person's non-wage income is $r\hat{T}t\left(n\right)$.
- Each person has a *reservation wage* which must as a minimum be offered if he is to accept a job in the competitive labour market.
- For high n-persons this reservation wage is high as they receive a high rental income.
  - Their utility from leisure is high.
- For low n-persons (say the landless), reservation wage is low, but possibly not nil.
  - We are concerned with malnutrition, not starvation.
    - The landless do not starve if they fail to find jobs in the labour market.
      - They beg, do odd jobs outside the economy under review, which keep them undernourished; but they do not die.

- Thus the reservation wage of even the landless exceeds their RMR.
  - All we assume is that at this reservation wage a person is malnourished.

- Denote by $\bar{w}(R)$ the reservation wage function; R denotes non-wage income.

- Assume the $\bar{w}(R)$ *function* is exogenously given (continuous and non-decreasing).
  - Of course, non-wage income is endogenous to the model.

- This reservation wage function is depicted in Figure 3.
  - For a given $r > 0$, $\bar{w}\left(r\hat{T}t(n)\right)$ is constant for all $n \in [0, \underline{n}]$ since all these n-persons are identical.
  - After that $\bar{w}\left(r\hat{T}t(n)\right)$ increases in n.

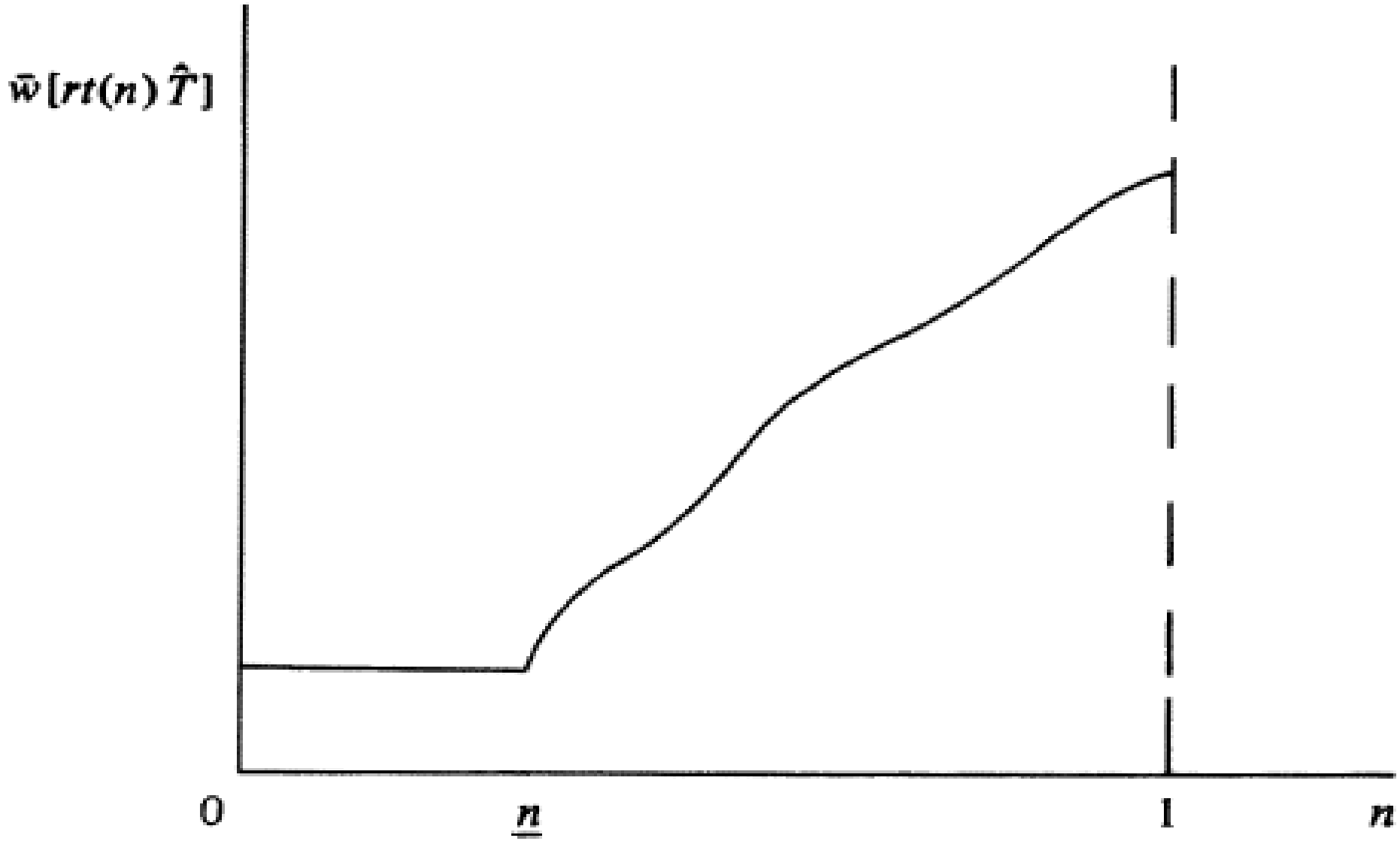


Fig. 3

- Malnutrition:

  For concreteness choose the consumption level $\hat{I}$ in Figure 1 as the cut-off consumption level below which a person is said to be undernourished.

  – At $\hat{I}$ marginal labour power equals average labour power.

  – $\hat{I}$ is then the food-adequacy standard.

  – Nothing of analytical consequence depends on this choice.

    ○ All that is needed is the assumption that the reservation wage of a landless person is one at which he is undernourished, and thus less than $\hat{I}$.

- Involuntary Unemployment:

  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*.

  – Involuntary unemployment has to do with differential treatment meted out to similar people.

1.1.2 Efficiency Wage

- To keep the exposition simple rest of the paper specializes somewhat and assume that $\lambda(I)$ is of the form given in Figure 1(b).

- The *efficiency-wage*, $w^*(n,r)$, of n-person is defined as

$$w^*(n,r) \equiv \arg \min_{w \geq \bar{w}\left(r\hat{T}t(n)\right)} \frac{w}{\lambda\left(w + r\hat{T}t(n)\right)}. \tag{1}$$

  - $w^*(n,r)$ is the wage per unit of labour-*time* which, at the rental rate r, minimizes the wage per unit of labour *power* of n-person, conditional on his being willing to work at this wage rate.

    - Since the n-person's reservation wage $\bar{w}\left(r\hat{T}t(n)\right)$ depends on the rental rate, his efficiency-wage depends, in general, on r.

- The minimization problem in (1) is equivalent to:

$$\underset{w \geq \bar{w}\left(r\hat{T}t(n)\right)}{\text{Maximize}} \ \frac{\lambda\left(w + r\hat{T}t\left(n\right)\right)}{w}.$$

Form the Lagrangian $\mathcal{L} = \dfrac{\lambda\left(w + r\hat{T}t\left(n\right)\right)}{w} + \xi \cdot \left[w - \bar{w}\left(r\hat{T}t\left(n\right)\right)\right]$, so that the F.O.C. are given by

$$\frac{w \cdot \lambda'\left(w + r\hat{T}t\left(n\right)\right) - \lambda\left(w + r\hat{T}t\left(n\right)\right)}{w^2} + \xi = 0, \tag{a}$$

and

$$\xi \cdot \left[w - \bar{w}\left(r\hat{T}t\left(n\right)\right)\right] = 0, \ \xi \geq 0, \text{ and } w \geq \bar{w}\left(r\hat{T}t\left(n\right)\right). \tag{b}$$

- When the reservation wage constraint is not binding ($w^*(n,r) > \bar{w}\left(r\hat{T}t(n)\right)$),
  - Then $\xi = 0$, so that (a) implies

$$\lambda'\left(w^*(n,r) + r\hat{T}t(n)\right) = \frac{\lambda\left(w^*(n,r) + r\hat{T}t(n)\right)}{w^*(n,r)} \tag{c}$$

- For the landless, that is, for $n \in [0, \underline{n}]$, $t(n) = 0$, implying $I = w^*(n,r) + r\hat{T}t(n) = w^*(n,r)$, so that (c) implies

$$\lambda'(I) = \frac{\lambda(I)}{I} \Rightarrow I = \hat{I} \Rightarrow w^*(n,r) = \hat{I}.$$

  - Recall that, by hypothesis, $\hat{I}$ exceeds the reservation wage of the landless.
    - This confirms that for the landless we are under the case when the reservation wage constraint is not binding.

- For one who owns a tiny amount of land, that is, n is just above $\underline{n}$ and $t(n)$ is positive but small enough so that the reservation wage constraint continues not to bind, (c) implies

$$\lambda'(I) = \frac{\lambda\left(w^*(n,r) + r\hat{T}t(n)\right)}{w^*(n,r)} > \frac{\lambda(I)}{I} \text{ since } I = w^*(n,r) + r\hat{T}t(n) > w^*(n,r),$$

$$\Rightarrow I < \hat{I},$$

$$\Rightarrow \bar{w}\left(r\hat{T}t(n)\right) < w^*(n,r) < \hat{I}.$$

  - That is, for one who owns a tiny amount of land, $w^*(n,r) < \hat{I}$, and, at the same time, $I < \hat{I}$.

- What happens to $w^*(n,r)$ and I as n increases further, that is, for those who owns larger amounts of landholding?

- Note that as long as the reservation wage constraint is not binding, (c) continues to hold.

- Total differentiating (c) we derive the following:

$$\frac{dw^*}{dn} = r\hat{T}t'(n)\left[\frac{\lambda'(I)}{\lambda''(I)} - 1\right] < 0, \text{ and } \frac{dI}{dn} = \frac{dw^*}{dn} + r\hat{T}t'(n) = r\hat{T}t'(n)\left[\frac{\lambda'(I)}{\lambda''(I)}\right] < 0.$$

  – That is, the efficiency wage decreases with increase in landholding and, as a result, income of these small landowners decline.

  $\Rightarrow$ For these small landowners also we continue to have

$$I < \hat{I}, \text{ and } \bar{w}\left(r\hat{T}t(n)\right) < w^*(n, r) < \hat{I}.$$

- But how long will it continue?

  – Note we started with the landless for whom $w^*(n, r) = \hat{I} >$ their reservation wage.

    ◦ Then as $n \uparrow$, $\bar{w}\left(r\hat{T}t(n)\right) \uparrow$, but $w^*(n, r) \downarrow$.

  $\Rightarrow$ Continuing this way we can identify an n_0 such that $w^*(n_0, r) = \bar{w}\left(r\hat{T}t(n_0)\right)$.

- So we conclude one with considerable amount of land, $n > n_0$,

$$w^* (n, r) = \bar{w} \left(r\hat{T}t (n) \right).$$

- Finally, for one who owns a great deal of land we would expect,

$$w^* (n, r) = \bar{w} \left(r\hat{T}t (n) \right) > \hat{I}.$$

- Define $\mu^{*}(n,r)$ as

$$\mu^{*}(n,r) \equiv \frac{w^{*}(n,r)}{\lambda\left(w^{*}(n,r)+r\hat{T}t(n)\right)}. \tag{2}$$

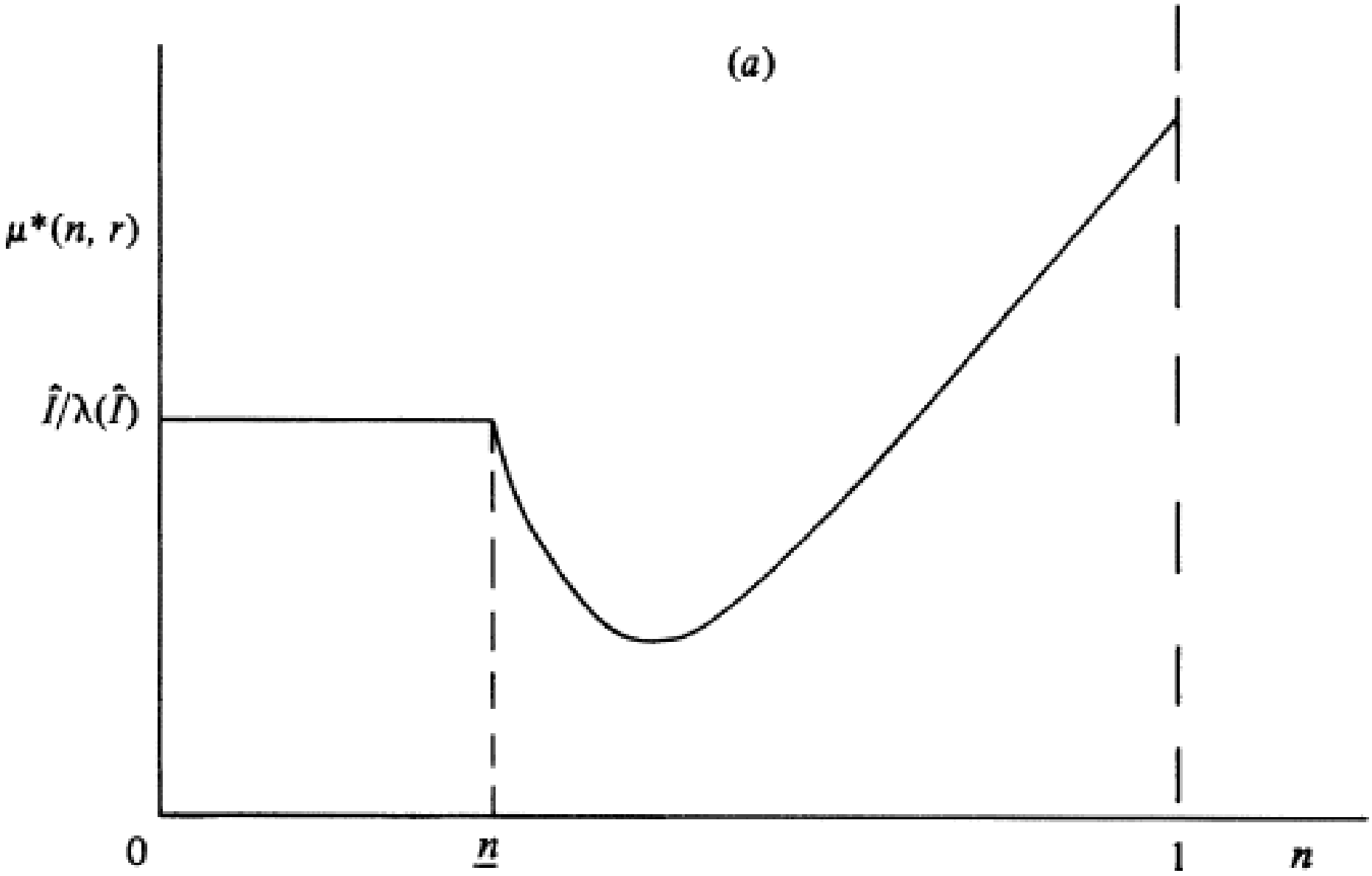
  - Given r, $\mu^{*}(n,r)$ is the minimum wage per unit of labour power for n-person, subject to the constraint that he is willing to work.

- Bliss and Stern (1978) interpreted $\lambda(I)$ as the (maximum) *number of tasks* a person can perform by consuming I.

  - In this interpretation we may regard $\mu^{*}(n,r)$ as the *efficiency-piece-rate* of n-person.

    - In what follows we will so regard it.

- In Figure 4(a) a typical $\mu^* (n, r)$ curve has been drawn.
  - $\mu^* (n, r)$ is 'high' for the landless because they have no non-wage income.
    - For the landless, $\mu^* (n, r) = \dfrac{\hat{I}}{\lambda\left(\hat{I}\right)}$.
  - It is relatively 'low' for 'smallish' landowners because they do have some non-wage income and because their reservation wage is not too high.
  - It is 'high' for the big land-owners because their reservation wages are very high.


(a)
μ*(n, r)
Î/λ(Î)
0
n̲
1
n

- While a 'typical' shape of $\mu^*(n,r)$, as in Figure 4(a) is used to illustrate the arguments in the main body of the paper,
  - the assumptions do not, in general, generate this 'U-shaped' curve.
  - For a given r, the common features of $\mu^*(n,r)$ are:

(a) $\mu^*(n,r)$ is constant for all landless n-persons and falls immediately thereafter.

(b) $\mu^*(n,r)$ continues to decrease in n as long as the reservation wage constraint is not binding.

$\Rightarrow$ Whenever $\mu^*(n,r)$ increases with n, the reservation wage constraint is binding.

$$\circ\ \frac{d\mu^*(n,r)}{dn} = \frac{\frac{dw^*(n,r)}{dn}\left[\lambda(\cdot) - w^*(n,r)\lambda'(\cdot)\right] - w^*(n,r)\lambda'(\cdot)r\hat{T}t'(n)}{\left[\lambda(\cdot)\right]^2}.$$

- When the reservation wage constraint is not binding, $\lambda(\cdot) = w^*(n,r)\lambda'(\cdot)$, implying that $\frac{d\mu^*(n,r)}{dn} < 0$.

(c) Once the reservation wage constraint binds for some n-person, it continues to bind for all n-person with more land.

◦ We have argued that the reservation wage constraint start binding at n_0 defined by

$$w^*(n_0, r) = \bar{w}\left(r\hat{T}t(n_0)\right),$$

where $w^*(n, r)$ satisfies equation (c) so that, as argued earlier, $\frac{d}{dn}w^*(n, r) < 0$.

- Since both $\bar{w}'(\cdot) > 0$ and $t'(n) > 0$, it follows that the constraint continues to bind for all $n \geq n_0$.

(d) $\mu^*(n, r)$ finally rises as the effect of increasing reservation wage ultimately outweighs the diminishing increments to labour power associated with greater landownership.

1.1.3 Market Equilibrium

- Markets are competitive, and there are two factors – land and labour power.

$\Rightarrow$ Two competitive prices to reckon with: rental rate on land, r, and price of a unit of labour power, that is, the *piece rate*, μ.

- $D(n)$: the market demand for the labour *time* of n-person;
  $S(n)$: the n-person's labour (time) supply.

  – By assumption $S(n)$ is either zero or unity.

- $w(n)$: the wage rate for n-person; G: the set of n-persons who find employment.

- Production enterprises are profit maximizing.

- Each n-person aims to maximize his income given the opportunities he faces.

- *A rental rate* $\tilde{r}$, *a piece rate* $\tilde{\mu}$, *a subset* $\tilde{G}$ *of* $[0,1]$ *and a real-valued function* $\tilde{w}(n)$ *on* $\tilde{G}$ *sustain a competitive equilibrium if and only if*:

(i) *for all* n*-persons for whom* $\tilde{\mu} > \mu^* (n, \tilde{r})$, *we have* $S(n) = D(n) = 1$;

(ii) *for all* n*-persons for whom* $\tilde{\mu} < \mu^* (n, \tilde{r})$, *we have* $S(n) = D(n) = 0$;

(iii) *for all* n*-persons for whom* $\tilde{\mu} = \mu^* (n, \tilde{r})$, *we have* $S(n) \geq D(n)$, *where*

- $D(n)$ *is either* 0 *or* 1 *and*
- $$S(n) = \begin{cases} 1 & \text{if } \tilde{w}(n) > \bar{w}\left(\tilde{r}\hat{T}t(n)\right), \\ \text{either } 0 \text{ or } 1 & \text{if } \tilde{w}(n) = \bar{w}\left(\tilde{r}\hat{T}t(n)\right); \end{cases}$$

(iv) $\tilde{G} = \{n\colon D(n) = 1\}$ *and* $\tilde{w}(n)$ *is the larger of the (possibly) two solutions of*

$$\frac{w}{\lambda\left(w + \tilde{r}\hat{T}t(n)\right)} = \tilde{\mu}, \text{ for all } n \text{ with } D(n) = 1;$$

(v) $\tilde{\mu} = \partial F\left(\tilde{E}, \hat{T}\right)/\partial E$, *where* $\tilde{E}$ *is the aggregate labour power supplied by all who are employed*; *and*

(vi) $\tilde{r} = \partial F\left(\tilde{E}, \hat{T}\right)/\partial T$.

- Conditions (v) and (vi):

  Since producers are competitive, $\tilde{r}$ in equilibrium must be equal to the marginal product of land and $\tilde{\mu}$ the marginal product of aggregate labour power.

- Condition (ii):

  We conclude from (v) that the market demand for the labour time of an n-person whose efficiency-piece-rate exceeds $\tilde{\mu}$ must be nil.

  Equally, such a person cannot, or, given his reservation wage, will not, supply the labour quality the market bears at the going piece rate $\tilde{\mu}$.

  – Suppose he were employed at wage $w \geq \bar{w}\left(\tilde{r}\hat{T}t\,(n)\right)$.

    ○ He can earn this wage only if he is physically capable of delivering the job, that is, $\tilde{\mu} \cdot \lambda\left(w + \tilde{r}\hat{T}t\,(n)\right) \geq w$.

$$\Rightarrow \frac{w}{\lambda\left(w + \tilde{r}\hat{T}t\,(n)\right)} \leq \tilde{\mu} < \mu^*\,(n, \tilde{r})\,,$$ contradicting the definition of $\mu^*\,(n, \tilde{r})$.

- Conditions (i) and (iv):

  Every enterprise wants an n-person whose efficiency-piece-rate is less than $\tilde{\mu}$.

  – His wage rate is bid up by competition to the point where his piece rate is $\tilde{\mu}$.

  – Demand for his labour time is positive.

  ∘ $$\frac{\tilde{w}(n)}{\lambda\left(\tilde{w}(n)+\tilde{r}\hat{T}t(n)\right)}=\tilde{\mu}>\mu^{*}(n,\tilde{r})=\frac{w^{*}(n,\tilde{r})}{\lambda\left(w^{*}(n,\tilde{r})+r\hat{T}t(n)\right)}$$

  $$\Rightarrow \tilde{w}(n)>w^{*}(n,\tilde{r}), \text{ since } \frac{d\mu}{dw}=\frac{\lambda(\cdot)-w\cdot\lambda'(\cdot)}{[\lambda(\cdot)]^{2}}\geq 0;$$

  $$\Rightarrow \tilde{w}(n)>w^{*}(n,\tilde{r})\geq \bar{w}\left(\tilde{r}\hat{T}t(n)\right),$$

  that is, the wage he is paid exceeds his reservation wage.

  $\Rightarrow$ He most willingly supplies his unit of labour time which, in equilibrium, is what is demanded.

- Condition (iii):

  What of an n-person whose efficiency-piece-rate equals $\tilde{\mu}?$

  – Enterprises are indifferent between employing and not employing such a worker.

  – He is willing to supply his unit of labour time:

    ◦ with eagerness if the wage he receives in equilibrium exceeds his reservation wage, and as a matter of indifference if it equals it.

- **Theorem 1.** *Under the conditions postulated, a competitive equilibrium exists*.

- A competitive equilibrium is not necessarily Walrasian.
  - It is not Walrasian when, for a positive fraction of the population, condition (iii) holds; otherwise it is.
  - If in equilibrium, condition (iii) holds for a positive fraction of the population, the labour market does not clear, and
    - we take it that the market sustains ‘equilibrium’ by *rationing*:
      - of this group a fraction is employed while the rest are kept out.

1.1.4 Simple Characteristics of Market Equilibrium

- We will characterize the equilibrium diagrammatically.
  - There are three different regimes depending on the size of $\hat{T}$.

- **Theorem 2.** *A competitive equilibrium is in one of three possible regimes, depending on the total size of land, $\hat{T}$, and the distribution of land. Given the latter*:

(1) *If $\hat{T}$ is sufficiently small, $\tilde{\mu} < \hat{I}/\lambda\left(\hat{I}\right)$, and the economy is characterized by malnourishment among all the landless and some of the near-landless*;

(2) *There are ranges of moderate values of $\hat{T}$ in which $\tilde{\mu} = \hat{I}/\lambda\left(\hat{I}\right)$, and the economy is characterized by malnourishment and involuntary unemployment among a fraction of the landless*;

(3) *If $\hat{T}$ is sufficiently large, $\tilde{\mu} > \hat{I}/\lambda\left(\hat{I}\right)$, and the economy is characterized by full employment and an absence of malnourishment*.

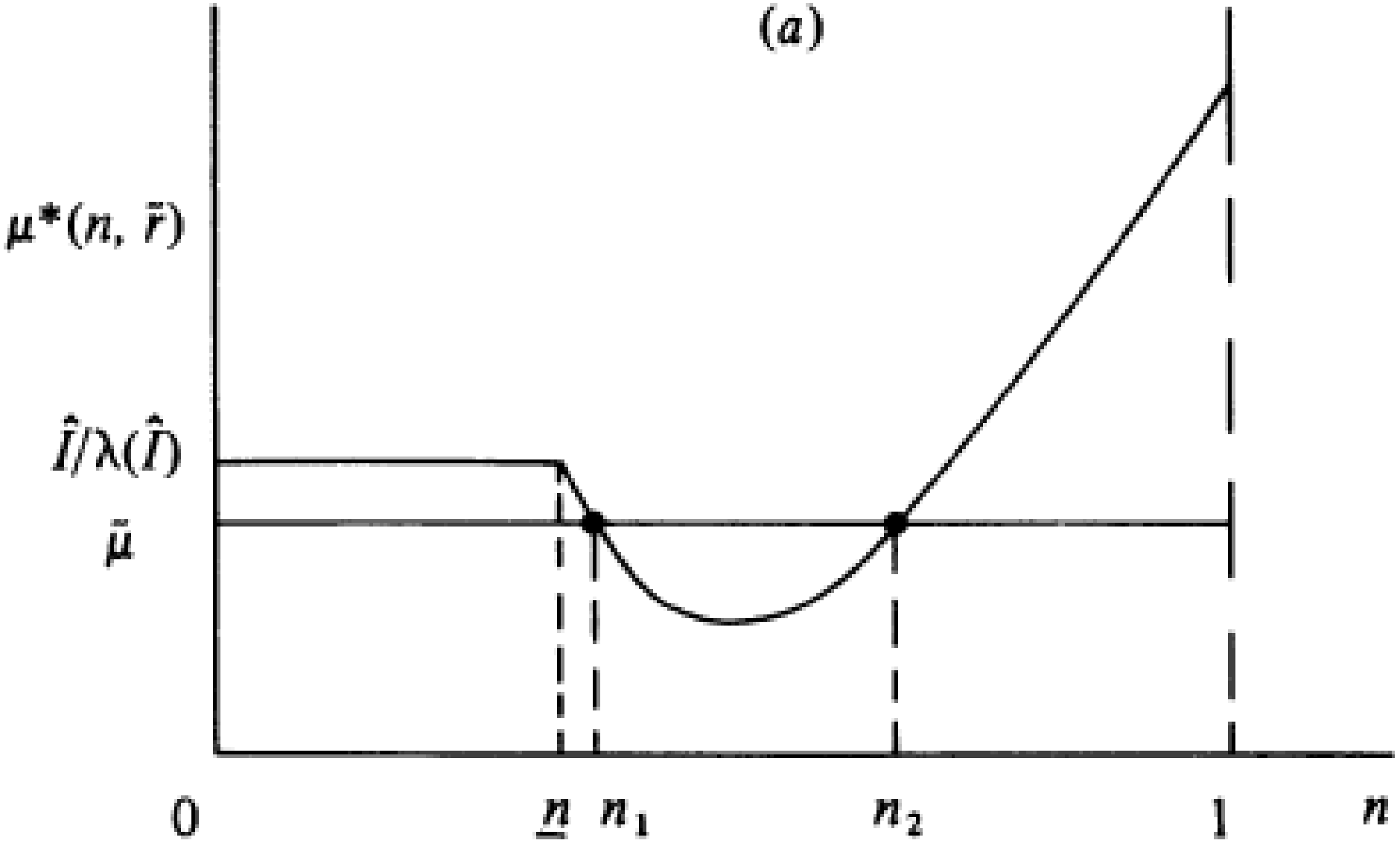
- Before discussing the equilibrium regimes we note that
  - among those in employment, persons owning more land are doubly blessed:
    - they not only enjoy more rental income, their wages are also higher.

- **Theorem 3.** *Let* $n_1, n_2 \in \tilde{G}$ *with* $t(n_1) < t(n_2)$. *Then* $\tilde{w}(n_1) < \tilde{w}(n_2)$.

- A strong implication of this result is that competition, in some sense, widens the initial disparities in asset ownership by offering larger (employed) land-owners a higher wage income.

1.1.4.1 Regime 1: Malnourishment among the Landless and Near-landless

- Figure 5(a) depicts a typical equilibrium under regime 1.
- Condition (i) $\Rightarrow$ all n-persons between n_1 and n_2 are employed in production.
  - Typically for the borderline n_1-person $\tilde{w}(n_1) > \bar{w}\left(\tilde{r}\hat{T}t(n_1)\right)$.
- Condition (ii) $\Rightarrow$ all n-persons below n_1 and above n_2 are out of the market:
  - the former because their labour power is too expensive,
  - the latter because their reservation wages are too high – they are too rich.
- In this regime all the landless are *malnourished*.
  - They enjoy their reservation wage which is less than $\hat{I}$.

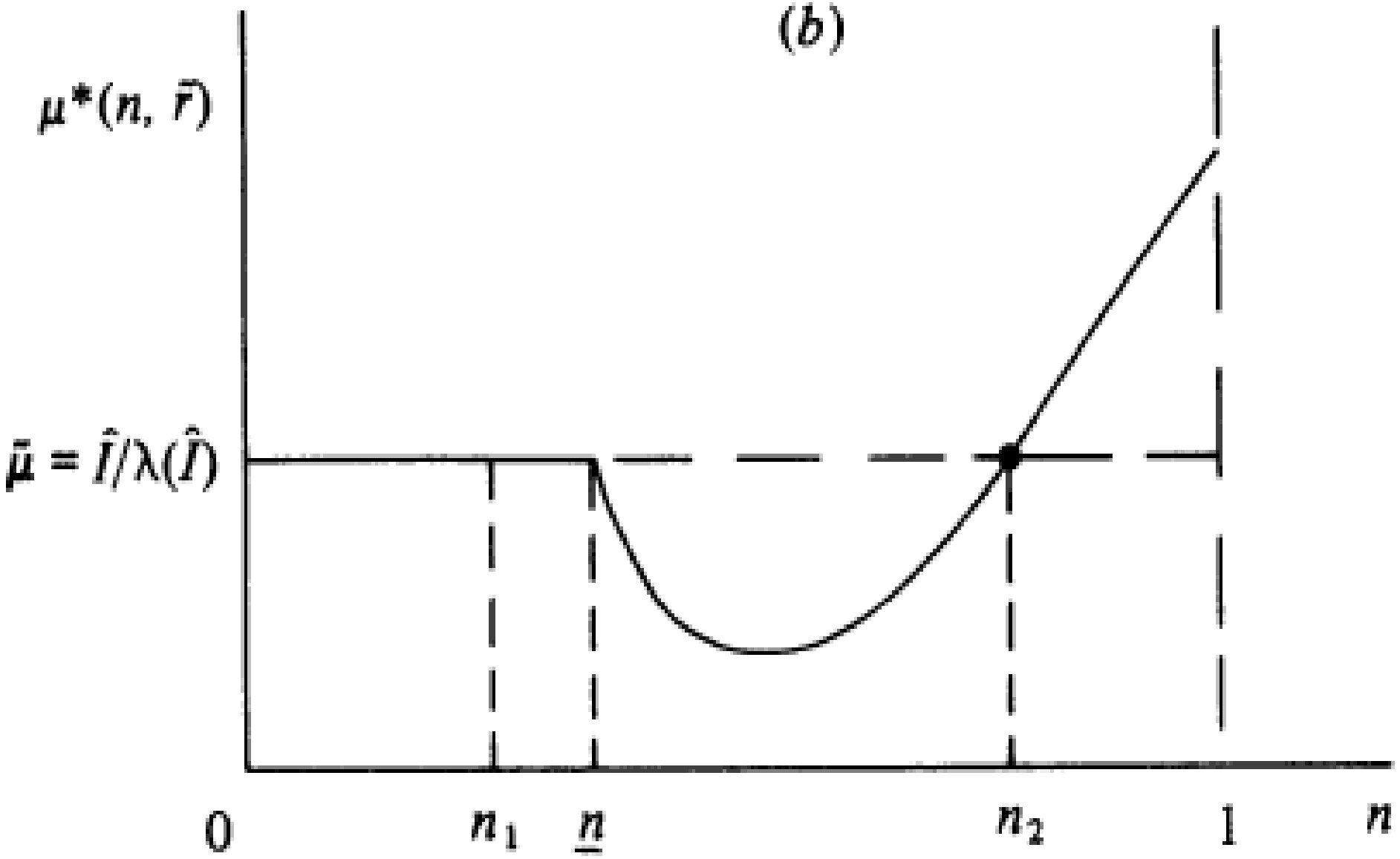

(a)
$\mu^*(n, \bar{r})$
$\hat{I}/\lambda(\hat{I})$
$\bar{\mu}$
0
$\underline{n}$
n_1
n_2
1
n

- All persons between $\underline{n}$ and n_1 are also *malnourished*;
  - their rental income is too meagre.
- Some of the employed are also *malnourished*;
  - the employed persons slightly to the right of n_1 consume less than $\hat{I}$.
- Although there are no job queues in the labour market; nevertheless, there is *involuntary unemployment*.
  - $\tilde{w}(n_1) > \bar{w}\left(\tilde{r}\hat{T}t(n_1)\right) \Rightarrow$ We also have $\tilde{w}(n) > \bar{w}\left(\tilde{r}\hat{T}t(n)\right)$ for all n in a neighbourhood to the right of n_1.
  - Since such people are employed, they are distinctly better off than the n-persons in a neighbourhood to the left of n_1,
    - who suffer at their reservation wage.

- Finally, the n-persons above n_2 are *voluntarily* unemployed.
  - Call them the pure rentiers, or the landed gentry.
    - They are capable of supplying labour at the piece-rate $\tilde{\mu}$ called for by the market, but *choose* not to;
      - their reservation wages are too high.
  - They are to be contrasted with the unemployed people below n_1 who are *incapable* of supplying labour at $\tilde{\mu}$.

1.1.4.2 Regime 2: Malnourishment and Involuntary Unemployment among the Landless

- The relevant curves are drawn in Figure 5(b).
- Here $\tilde{\mu} = \hat{I}/\lambda\left(\hat{I}\right)$.
  - It is not a zero-measure event: it pertains to certain intermediate ranges of $\hat{T}$.
- The economy equilibrates by rationing landless people in the labour market.
- Condition (i) $\Rightarrow$ all n-persons between $\underline{n}$ and n_2 are employed.
- Condition (ii) $\Rightarrow$ all n-persons above n_2 are out of the labour market because their reservation wages are too high.


(b)
$\mu^*(n, \bar{r})$
$\bar{\mu} = \hat{I}/\lambda(\hat{I})$
0
n_1
$\underline{n}$
n_2
1
n

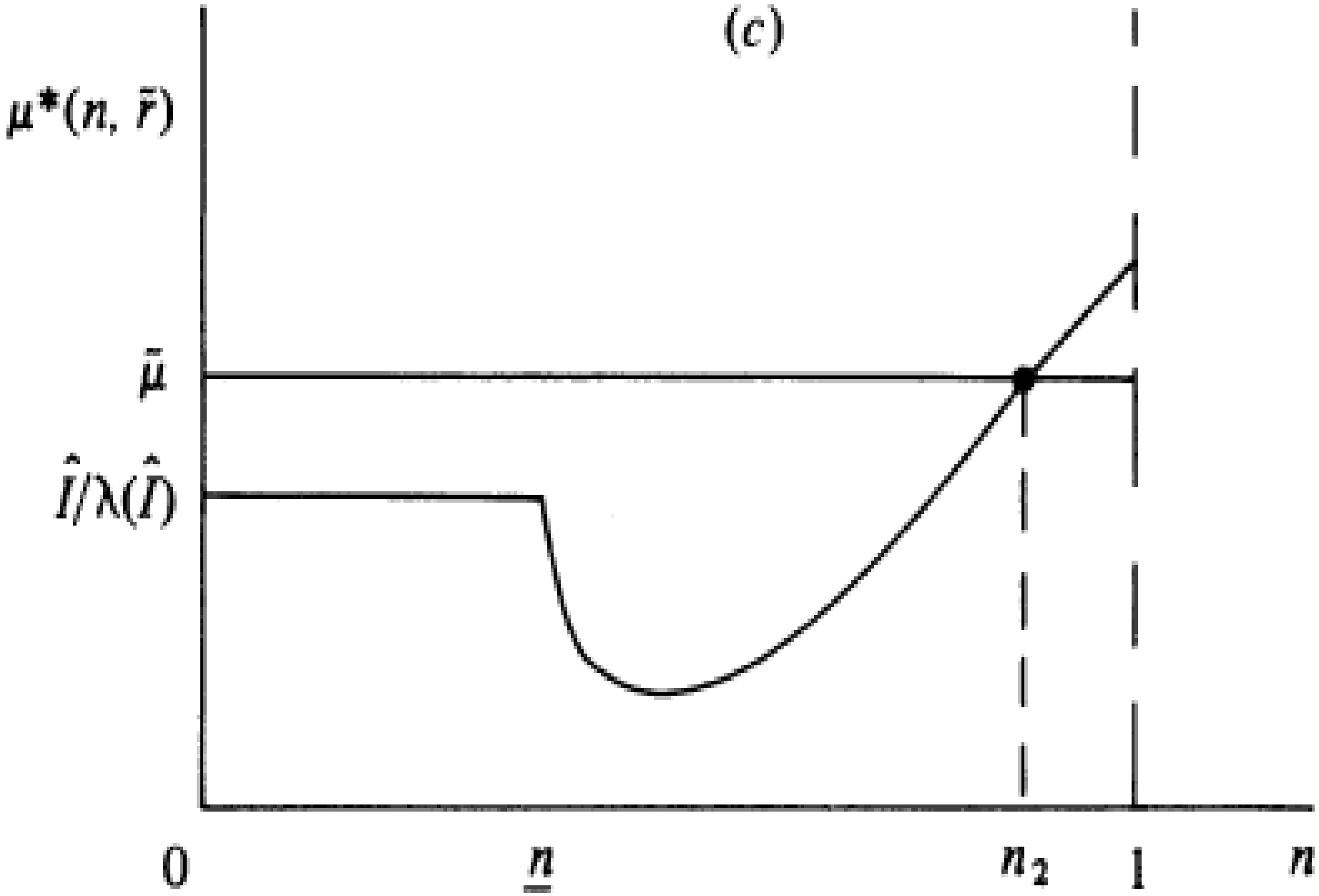
- A fraction of the landless, $\frac{n_1}{\underline{n}}$, is *involuntarily unemployed*;
  - the remaining fraction, $1 - \frac{n_1}{\underline{n}}$, is employed.
  - The size of this fraction depends on $\hat{T}$.
- The *employed* among the landless are paid $\hat{I} \Rightarrow$ *not* malnourished.
- The *unemployed* among the landless suffer their reservation wage.

$\Rightarrow$ They are *malnourished*.

- Under this regime, the group of unemployed and malnourished coincide
  - This is to be contrasted with Regime 1.

1.1.4.3 Regime 3: The Full Employment Equilibrium

- Figure 5(c) presents the third regime pertinent for large values of $\hat{T}$.
- Here $\tilde{\mu} > \hat{I}/\lambda\left(\hat{I}\right)$.
- Condition (i) $\Rightarrow$ all n-persons from 0 to n_2 are employed.
- Condition (ii) $\Rightarrow$ all n-persons above n_2 are out of the labour market.
  - They are the landed gentry, *not* involuntarily unemployed.
- This regime is characterized by full employment and no malnourishment.
- This corresponds to a standard Arrow-Debreu equilibrium.


(c)
$\mu^*(n, \bar{F})$
$\bar{\mu}$
$\hat{I}/\lambda(\hat{I})$
0
$\underline{n}$
n_2
1
n

1.2 The Vicious Circle of Poverty and Undernutrition

The Capacity Curve

- The capacity curve is a relationship between nutrition and work capacity.
  - Figure 13.3 displays a typical capacity curve.
    - Horizontal axis: Ideally we want to have ‘nutrition’, but we are considering ‘income’ with the implicit assumption that all income is spent on nutrition.
    - Vertical axis: ‘Work capacity’ is a measure of total number of tasks an individual can perform.
  - We have explained the shape of the capacity curve earlier (page 6).
- Thus, income determines work capacity, but work capacity determines income as well.
  - That is what we consider next.

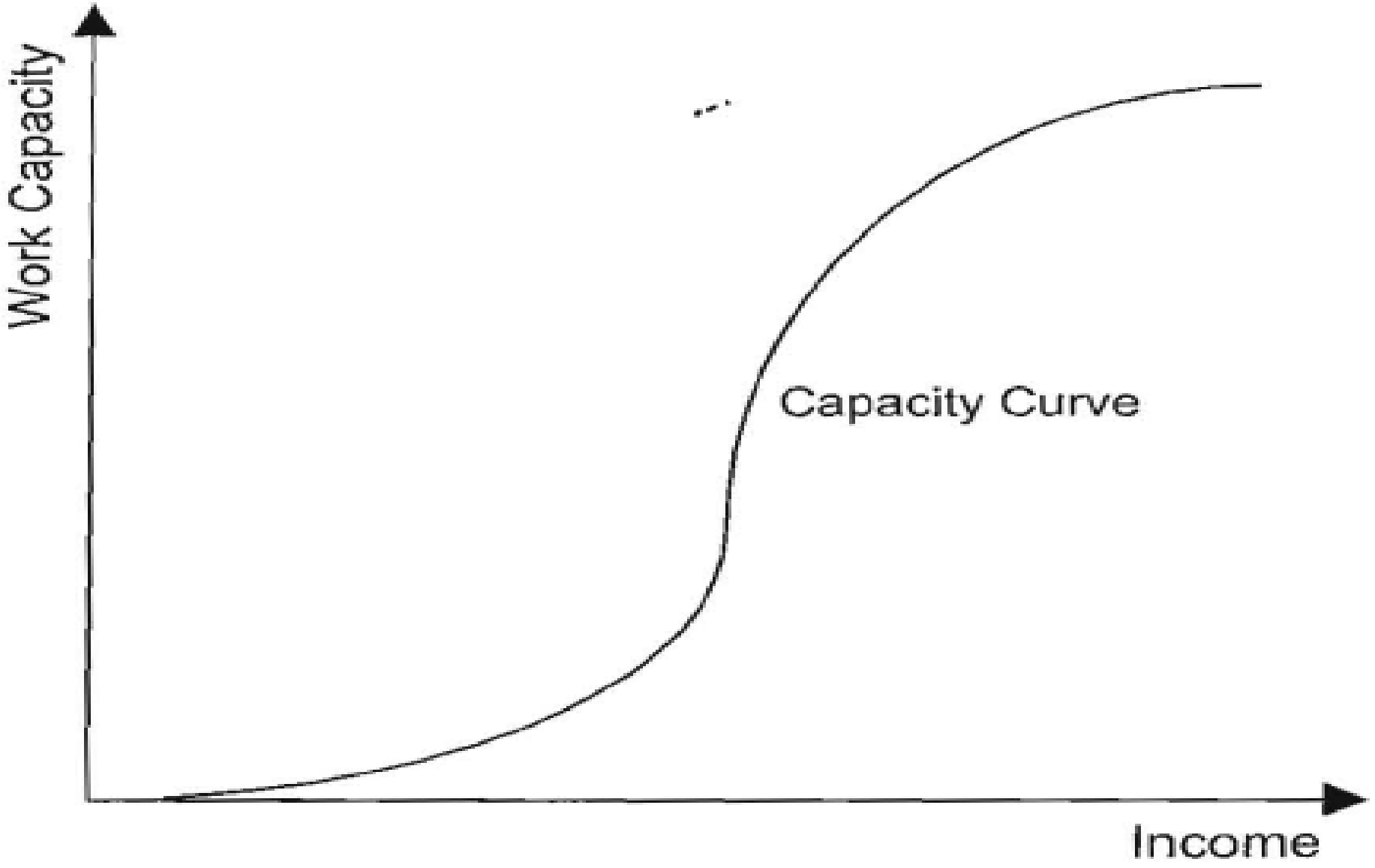


Figure 13.3. The capacity curve.

Piece Rates

- Piece rates are payments on the basis of tasks completed, such as 10 dollars per harvested bushel or 100 dollars per acre weeded.
  - If income is paid per unit of task – say 10 dollars per bushel harvested – then we see that there is a relationship between the number of tasks that are performed and total income.
  - Figure 13.4 draws the graph that portrays this relationship.
- Now we superimpose Figure 13.3 on Figure 13.4, the result is shown in Figure 13.5.
  - Four piece rates are shown: v_1, v_2, v_3, and v_4.
    - v_i refers to the piece rate such that the worker is paid v_i dollars for every bushel he harvests.
  - Note that $v_1 > v_2 > v_3 > v_4$.

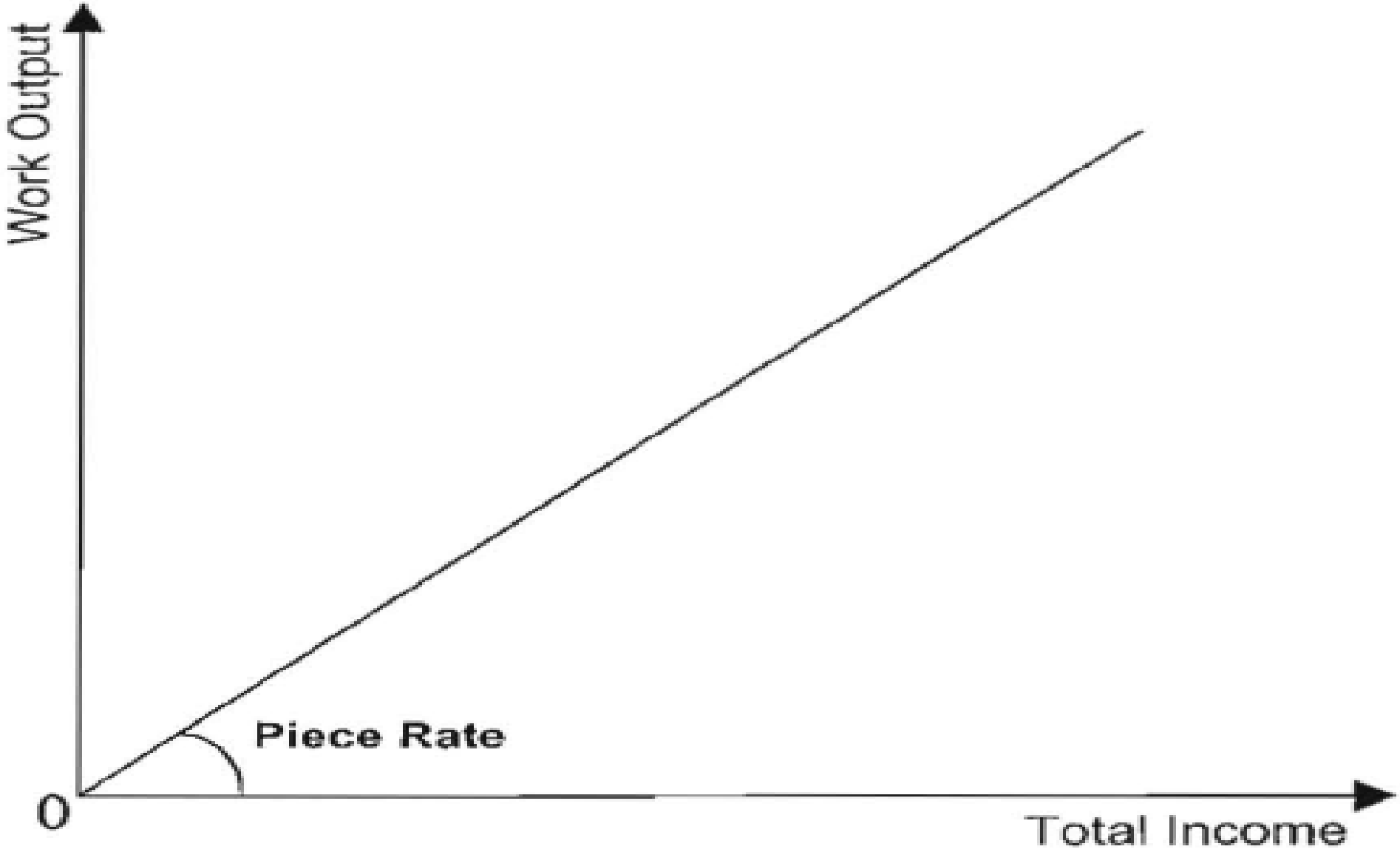


Figure 13.4. A piece rate.

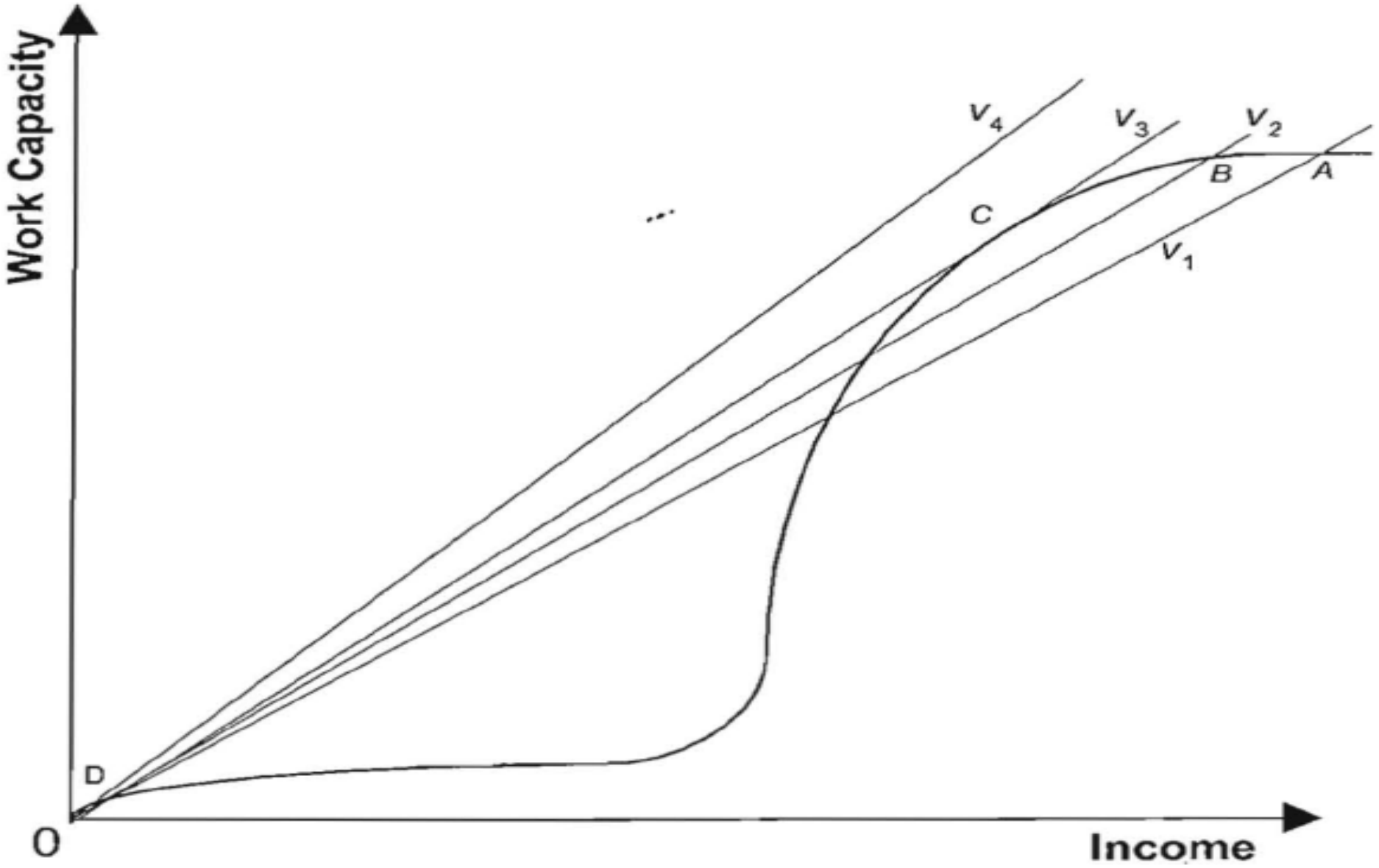


Figure 13.5. Piece rates and work effort.

Labour Supply

- Suppose that a labourer (Mr. X) tries to obtain the highest possible level of income that he can possibly earn, given the constraints imposed by his capacity curve.
  - If the going piece rate is v_1, Mr. X will choose the point A, which yields the largest possible feasible income for him.
  - As the piece rate drops to v_2, the maximum income falls.
    - He chooses the point B, which involves less total work and lower income.
  - The piece rate v_3 is just tangent to the capacity curve along its hump.
    - At this piece rate Mr. X can *just about* choose point C.
  - If the piece drops a little more, then the amount of work that Mr. X can supply drops dramatically to point D, the intersection of piece rate v_4 with the capacity curve.
    - This jump occurs precisely because of the particular shape of the capacity curve – with low levels of nutrition permitting only very low levels of work, and moderate to high levels creating a rapid increase in work capacity.

- We can use all this information to generate a supply curve of labour, which tells us the different levels of labour power supplied at different piece rates.
  - The left-hand panel of Figure 13.6 shows labour supply by Mr. X by simply transplanting the information from Figure 13.5.
  - The gap in labour supply at the piece rate v_3 captures our previous discussion that after a certain threshold wage individual labor supply must jump discontinuously.
- Figure 13.6 shows the transition from individual labour supply to aggregate labour supply.
  - The right-hand panel effectively multiplies the individual supply curve by the number of labourers to get the aggregate labour supply curve.

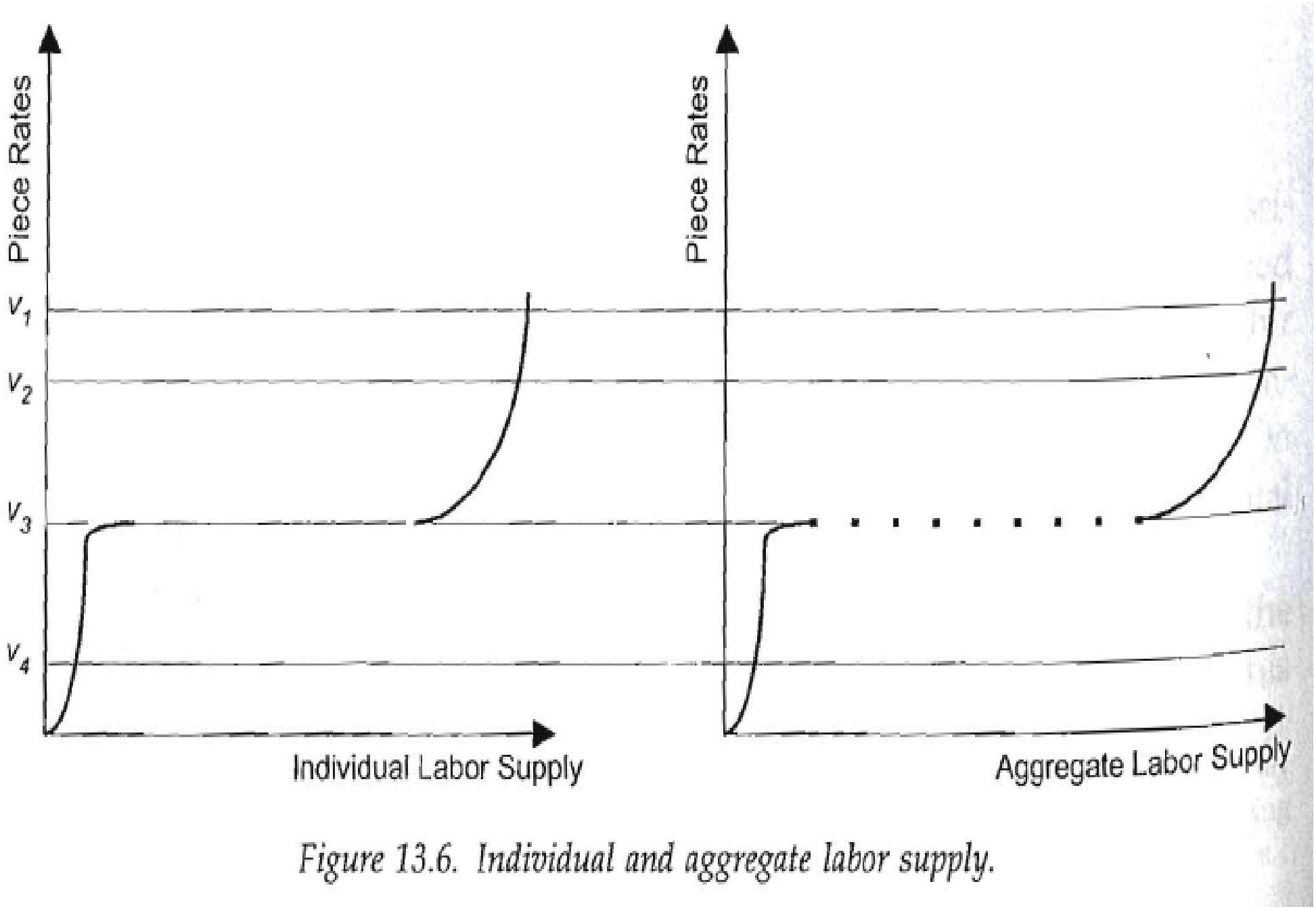


Figure 13.6. Individual and aggregate labor supply.

Equilibrium

- To complete our description of this labour market, we introduce a standard downward sloping *demand curve* for labour in Figure 13.7.
- The equilibrium occurs at the intersection of the demand and supply curves.
- Figure 13.7 compares two equilibrium situations.
- First case: Demand is large relative to supply.
  - The left panel of Figure 13.7 depicts this case.
  - The demand curve intersects the supply curve at a point that is beyond the gap in the supply curve.
  - This is a perfectly normal case:
    - The market clears in the standard fashion and determines an equilibrium piece rate v^*;
    - everybody gets to supply a “high” level of work effort, that is, a level of work effort that is somewhere on the hump of the capacity curve for each labourer.

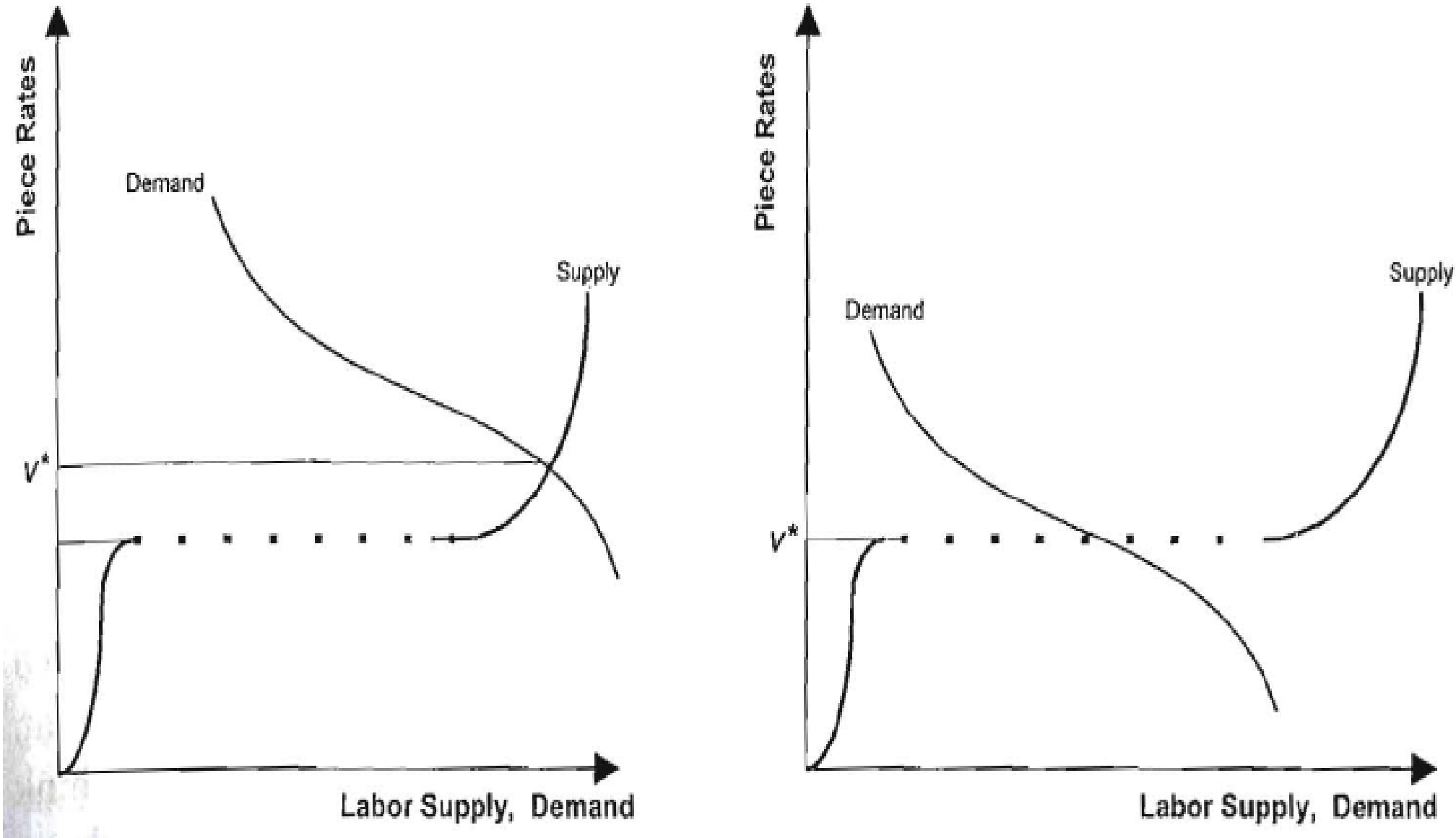


Figure 13.7. "Equilibrium" in the labor market.

- Second case: Supply is large relative to demand (right panel of Figure 13.7).
  - The demand curve passes through the dotted gap in the aggregate supply curve.
  - The piece rate v^* has the following interesting property:
    - if the rate is any larger than v^*, we have excess supply, which brings down the piece rate;
    - on the other hand, for piece rates below this critical level, there is excess demand, so that wages are bid up.
  - The piece rate v^* is the equilibrium rate *with unemployment*: there are some labourers who get work at this piece rate, whereas the labour market access is restricted to others.
  - This unemployment is *involuntary* in the sense that unemployed people are strictly worse off than their counterparts who are lucky to find employment.
  - However, the piece rate cannot be bid down because no one can “credibly” supply the same amount of labour at any lower piece rate.

The Vicious Cycle

- We see then that the vicious cycle is complete in this little model.
  - Lack of labour market opportunities makes for low wages.
  - But it is not only that wages determine work capacity: a low capacity to work feeds back on the situation by lowering access to labour markets!

Nonlabour Assets and the Labour Market

- We introduce the realistic possibility that people may have other sources of income.

$\Rightarrow$ It is not correct to equate total income with just the wages paid by the labour market.

  - For instance, in rural settings, some individuals may have tiny landholdings that are leased out for cultivation.
    - To the extent that such assets augment income possibilities, such individuals are more easily able to participate in the labour market.

- Figure 13.8 compares two individuals.
  - The left panel depicts another worker, Mr. Y, who has access to a source of non-labour income, of size R as rent from his own landholding.
    - Now work capacity depends on rent plus wages.
    - Since the horizontal axis involves only wage income, the work capacity curve is shifted horizontally to the left by the amount R.

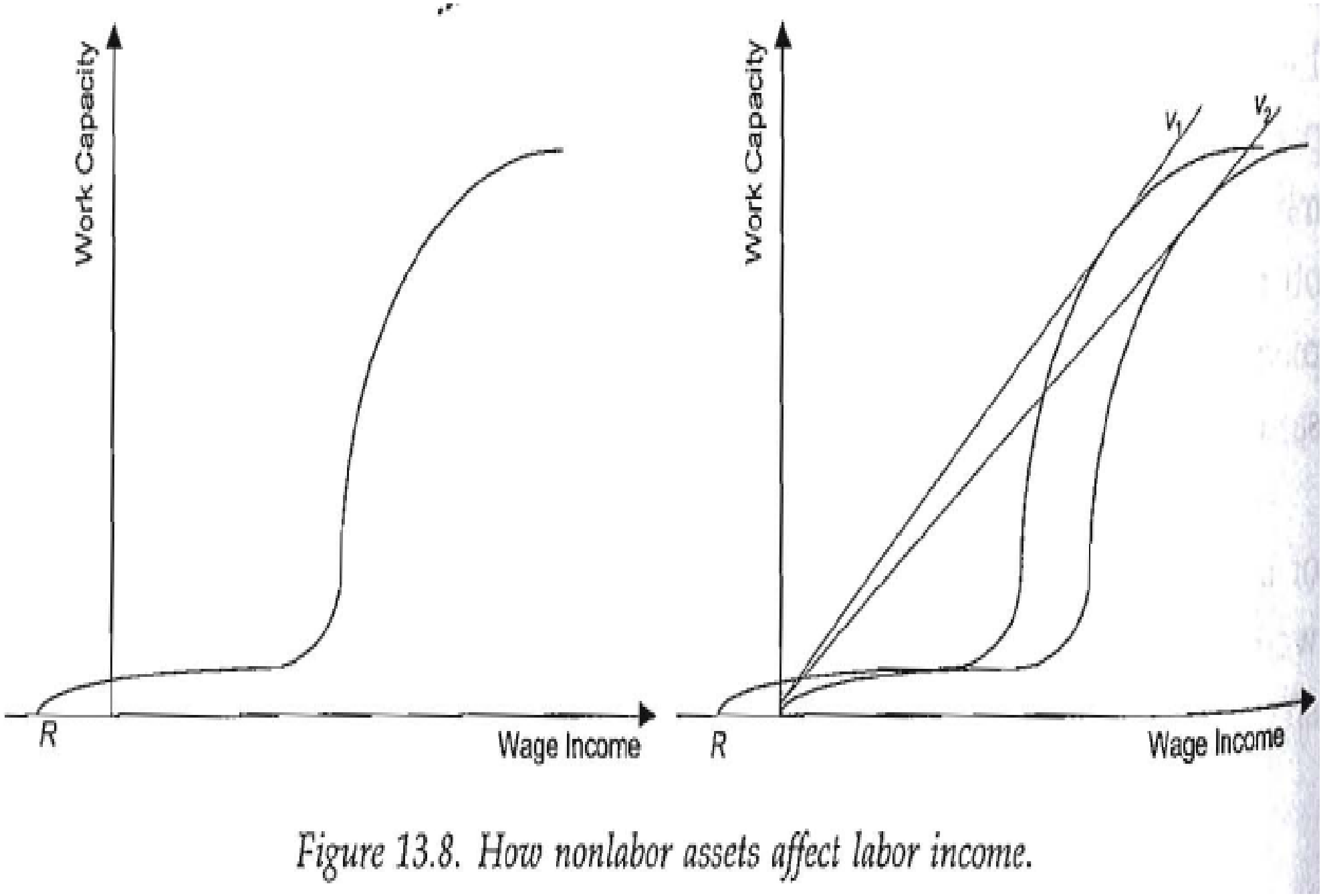


Figure 13.8. How nonlabor assets affect labor income.

- The right-hand panel superimposes this diagram on the corresponding picture for Mr. X, who has no sources of nonlabour income.
  - Although Mr. X's work capacity is just the same as Mr. Y, Mr. X's capacity curve lies to the right and below that of Mr. Y, just because Mr. Y enjoys some land rents.
- Under the piece rate v_1, Mr. X is only able to supply a tiny amount of labour – he is effectively excluded from the labour market.
  - But that is not the case for Mr. Y; he can still supply labour at v_1.
- Even if piece rates are so high that both can supply labour (as in the case of v_2), note that Mr. Y is still earning a larger income than Mr. X.
  - It is important to note that the larger size of Mr. Y's income is not just because of his nonlabour assets: *he earns higher wage income also*.
- Thus inequalities in the asset market magnify further into labour market inequalities, at least among the poor.
  - People without assets are doubly cursed – not only do they have no nonlabour income, they are at a disadvantage in the labour market also relative to those who possess assets.

Asset Inequality, Nonlabour Income and the Labour Market

- Let us probe further the effects of disparate asset holdings.
- Suppose that only one commodity is produced in the economy, food.
  - Food is produced using land and labour power.
- There are many individuals in this simplified economy.
  - Each person has the same capacity curve described above.
  - Different individuals own different quantities of land;
    - In particular, some individuals may be completely landless.
- Observe that the demand curve for labour is just the sum of the demands for labour that all households have to cultivate their land.

- For each person with or without landholdings, let us keep track of the *minimum piece rate* at which he will be able to supply labour to the labour market.
- The left-hand panel of Figure 13.9 illustrates the idea explained above.
  - People with greater amounts of nonlabour income (rental income from land, in this case) are able to supply their labour at a lower threshold piece rate.
    - The reason is that their rental income takes care of some of their nutritional needs.
- The right-hand of Figure 13.9 plots this minimum against people arranged in increasing order of land income.
  - People upto the index i^* are landless, so for them the minimum piece rate is unchanging.
  - Thereafter the minimum falls as land income increases.

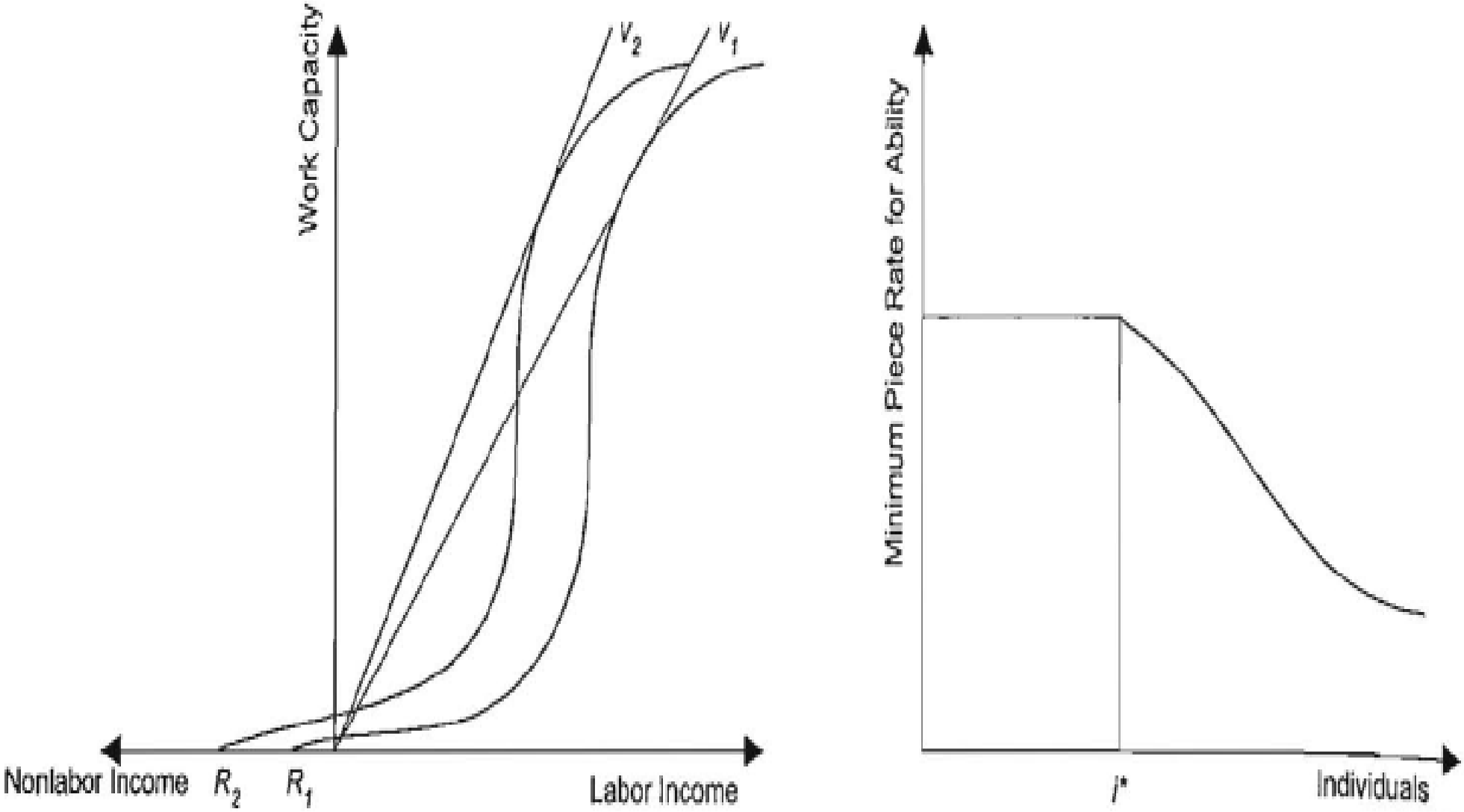


Figure 13.9. The minimum piece rate that determines ability to work.

- The minimum piece rate in Figure 13.9 represents the least amount for which an individual will be *able* to work on the labour market.

- However, there is an additional consideration.
  - Presumably, the minimum wage at which a person will be *willing* to work rises with the amount of nonlabour income.
    - The reason is that a person who has other sources of income, will value leisure more highly and will be willing to sacrifice it only for high enough compensation.

- Thus two opposing forces are at work here; but we can say something reasonable about the way they interact.
  - At very low levels of nonlabour income, people will be willing to work for anything.
    - So what really binds is the minimum piece rate at which they *can* work.
  - As nonlabour income increases, this “ability-based” minimum rate falls, and, at some point, the willingness to work becomes the binding constraint;
    - ability is no longer an issue.

- We may therefore combine the two minimum piece rates, shown as the heavy curve in Figure 13.10.
  - The resulting U-shaped curve represents the minimum piece rate at which individuals are willing *and* able to work.
- We can figure out which parts of the curve correspond to which regime.
  - Given that individuals are arranged in order of increasing nonlabour income,
    - the falling portion of the curve correspond to the zone in which ability is the operative constraint.
    - The rising part of the curve represents the zone in which willingness is the operative constraint.

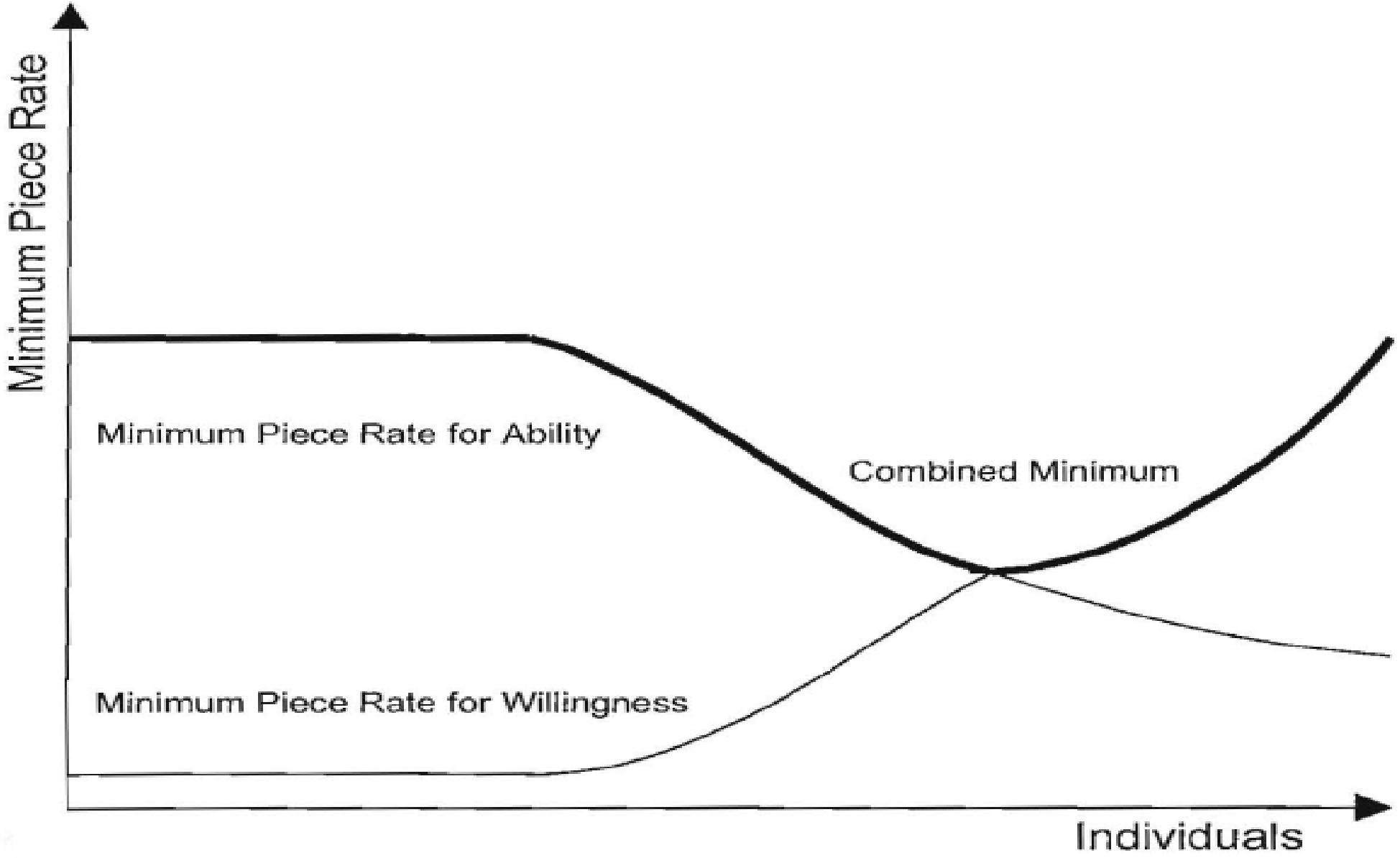


Figure 13.10. Ability and willingness: the combined effect.

- Figure 13.11 shows how to derive the supply curve of labour using Figure 13.10.
- For each piece rate in the market, the supply of labour is given by the amounts worked by all those whose minimum piece rates lie *below* the going market rate.
  - These are the individuals who are willing and able to work at the going piece rate.
  - By varying the piece rate, we trace out a supply curve.
- The demand curve is drawn just as before.
- The intersection of the two curves represents market equilibrium.
- The left-hand panel of Figure 13.11 displays one such piece rate and the segment of people who do supply labour at that piece rate, shown by the line AB.
- People to the “left” of A and to the “right” of B are unemployed.
  - But a closer look reveals that they are unemployed for very different reasons.

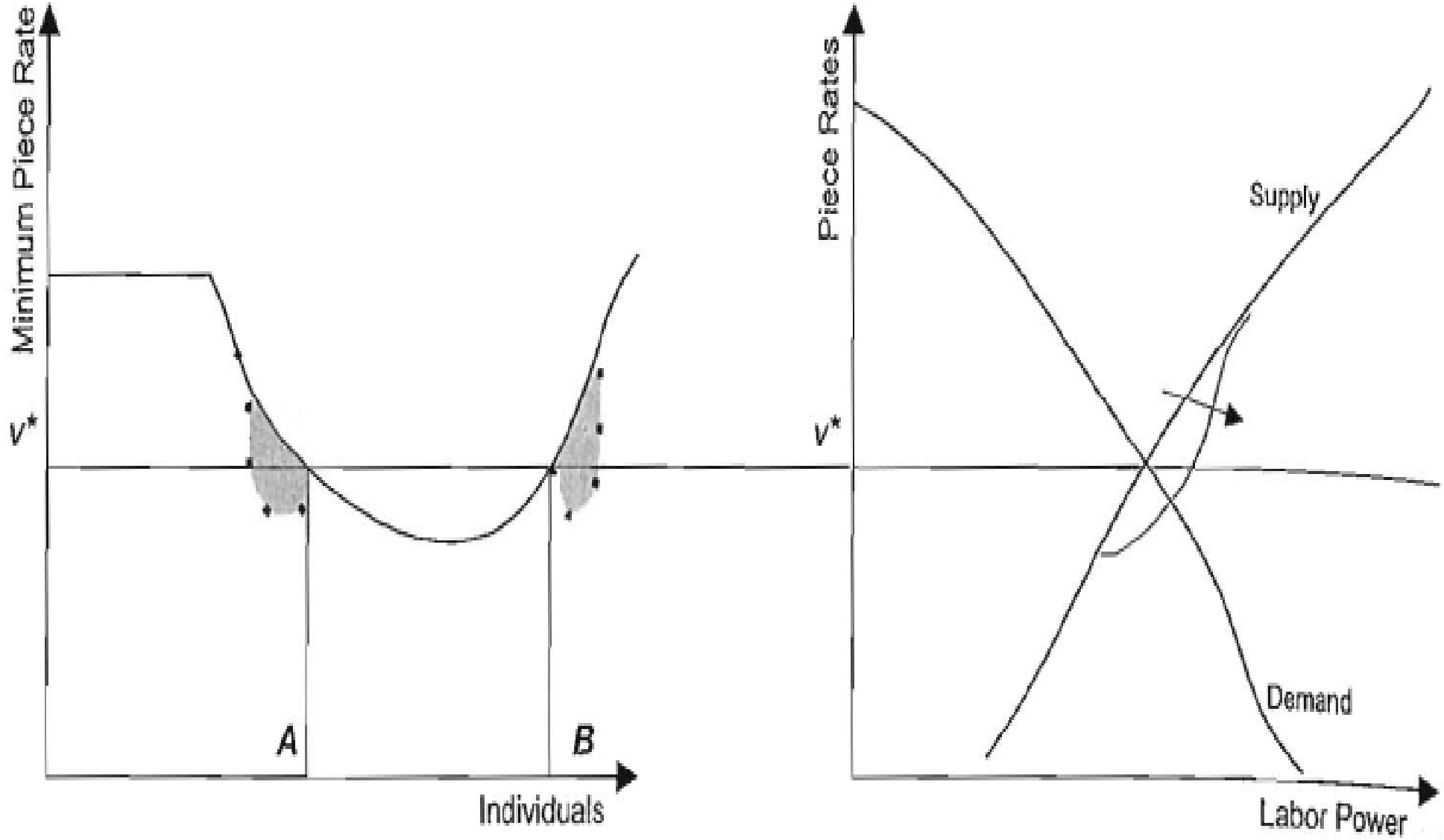


Figure 13.11. Market equilibrium.

- People to the right of B are *able* to work, but they do not wish to.
  - We can call them the *voluntarily unemployed*.
    - Their nonlabour incomes, derived from land rent, are too high for them to be attracted by the going piece rate.
- Contrast this with the individuals to the left of A.
  - They are unemployed not because they are unwilling to work, but because they are unable to work at the going piece rate.
    - Their resulting incomes are not high enough to reproduce the needed work capacity.
  - We can call them the *involuntarily unemployed*.

Policy Experiment: Land Reform

- We can use this model to analyze the effects of changes in the distribution of wealth holdings, say *land reform*.
- Suppose land is taken away from those who have a lot of it and given to those who have none or little of it.
- Certainly, such land reforms hurt those who lose land and benefit those who gain it.
  - However, we can say something about what happens to total output as a result.
- Refer to Figure 13.11.
  - Suppose that land holdings are transferred from the landed gentry just to the right of B to the involuntarily unemployed just to the left of A.

- There are two immediate effects of this transfer.
  - First, the beneficiaries of the reform become “more able” to work at the going piece rate in the market.
    - That is, their minimum piece rates come down as their nonlabour income has increased.
  - Second, the losers of land become more willing to work.
    - As their nonlabour income has decreased, so their minimum piece rates decline as well.
- Thus land reform has the effect of bringing down the minimum piece rate for all who are directly affected by the reform.
  - This is shown in Figure 13.11 by the dotted bulges that appear to the left of A and to the right of B.

- What is the effect on labour supply?
  - At the going piece rate depicted in Figure 13.11, labour supply must *increase*.
    - The reason is that there are some more people who are able to work, and there are more people who are willing to work.
  - This is shown by the dotted shift of the labour supply curve in the right-hand panel of Figure 13.11.
  - It follows that equilibrium labour use must go up.
  - This, in turn, implies that total output in the economy must *increase*.
- So a judicious land reform has the power to increase overall output in the economy.

Dynamic Version of the Capacity Curve

- Capacity curve:
  - Current health (h_t) affects future income (y_{t+1}): $y_{t+1} = g(h_t)$;
  - Current income (y_t) affects current health (h_t): $h_t = f(y_t)$.

$\Rightarrow$ Capacity curve is

$$y_{t+1} = g(f(y_t)).$$

- Different possibilities are illustrated in the following three figures.
  - When will a *poverty trap* emerge?

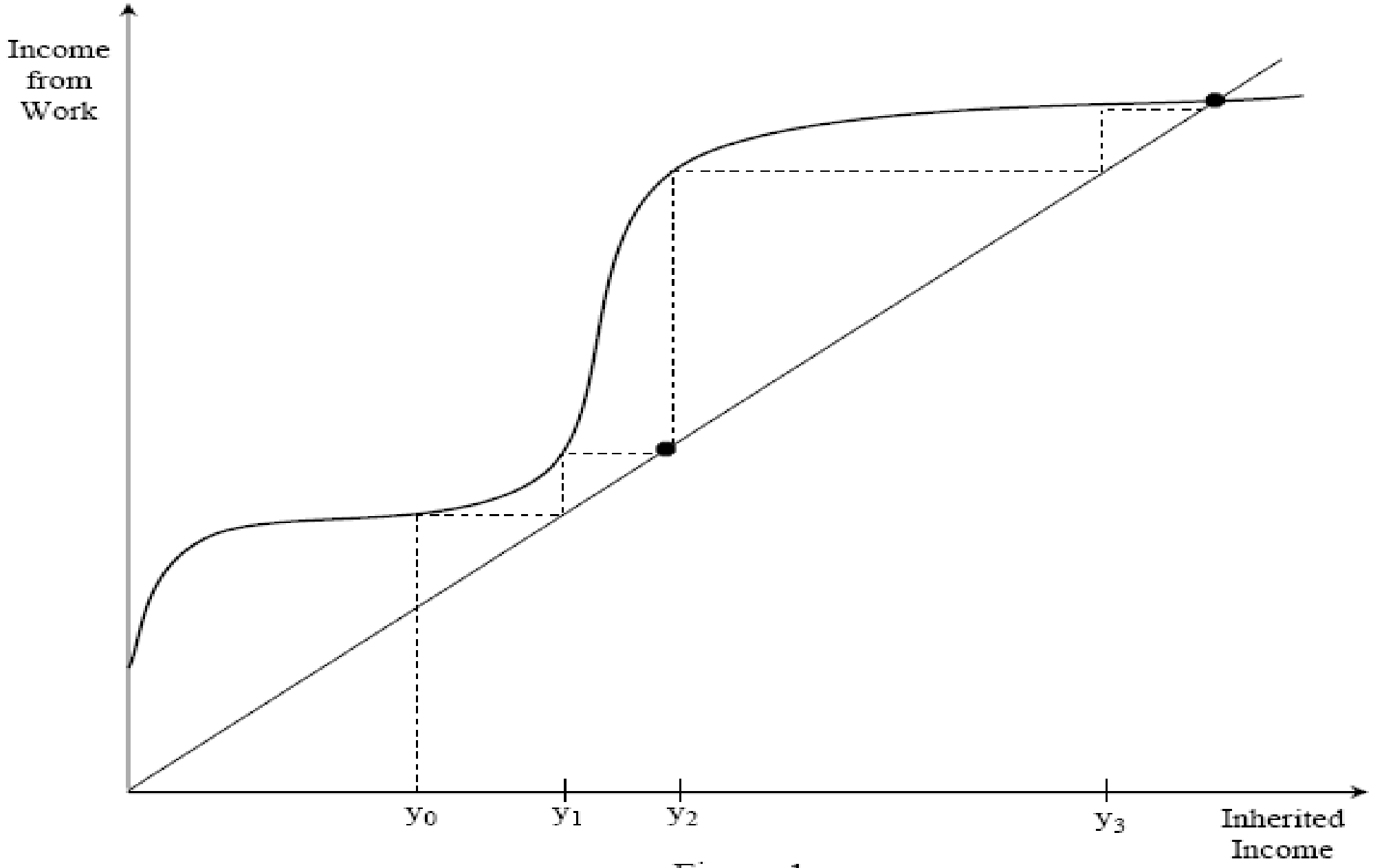


Figure 1

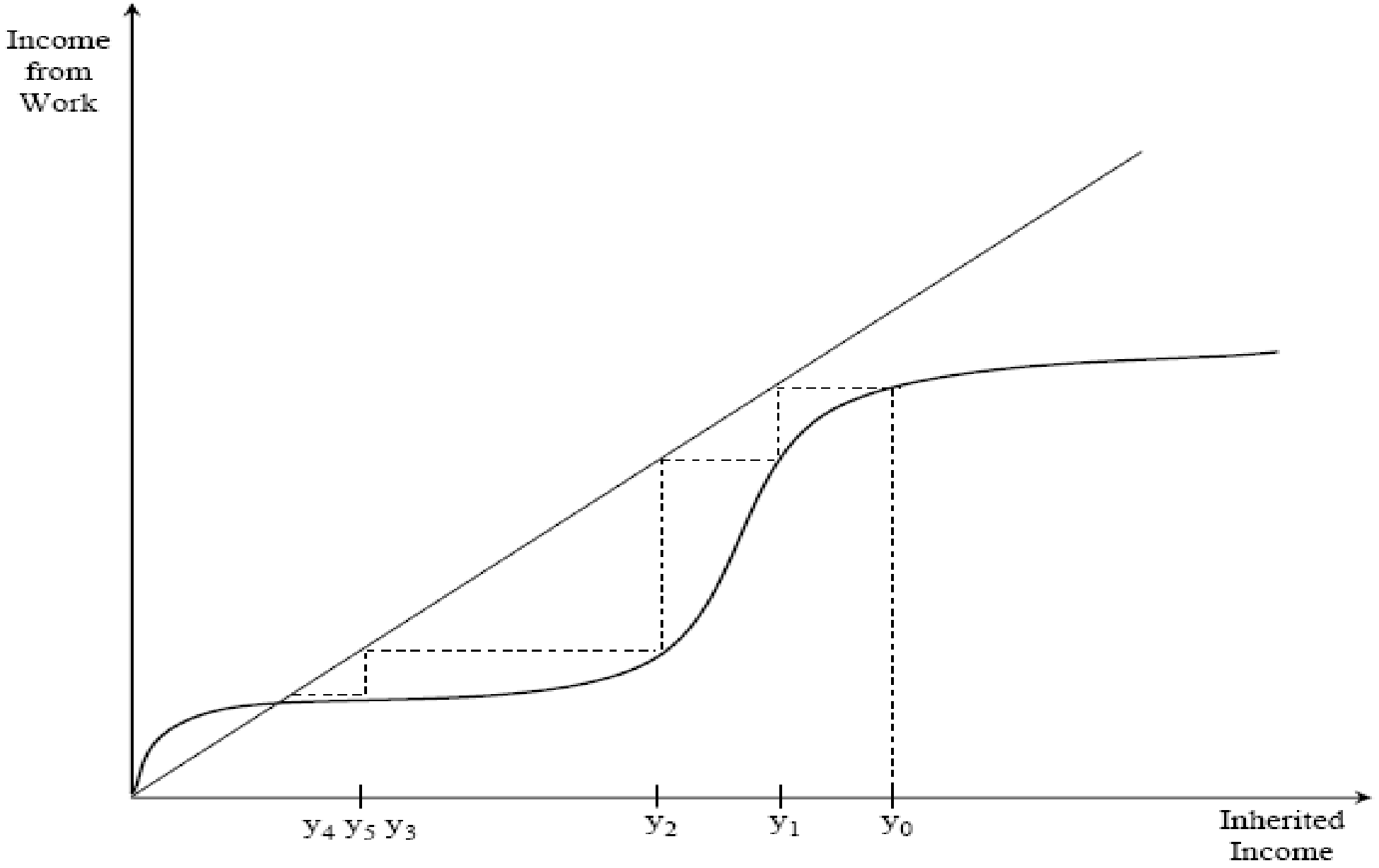


Figure 2

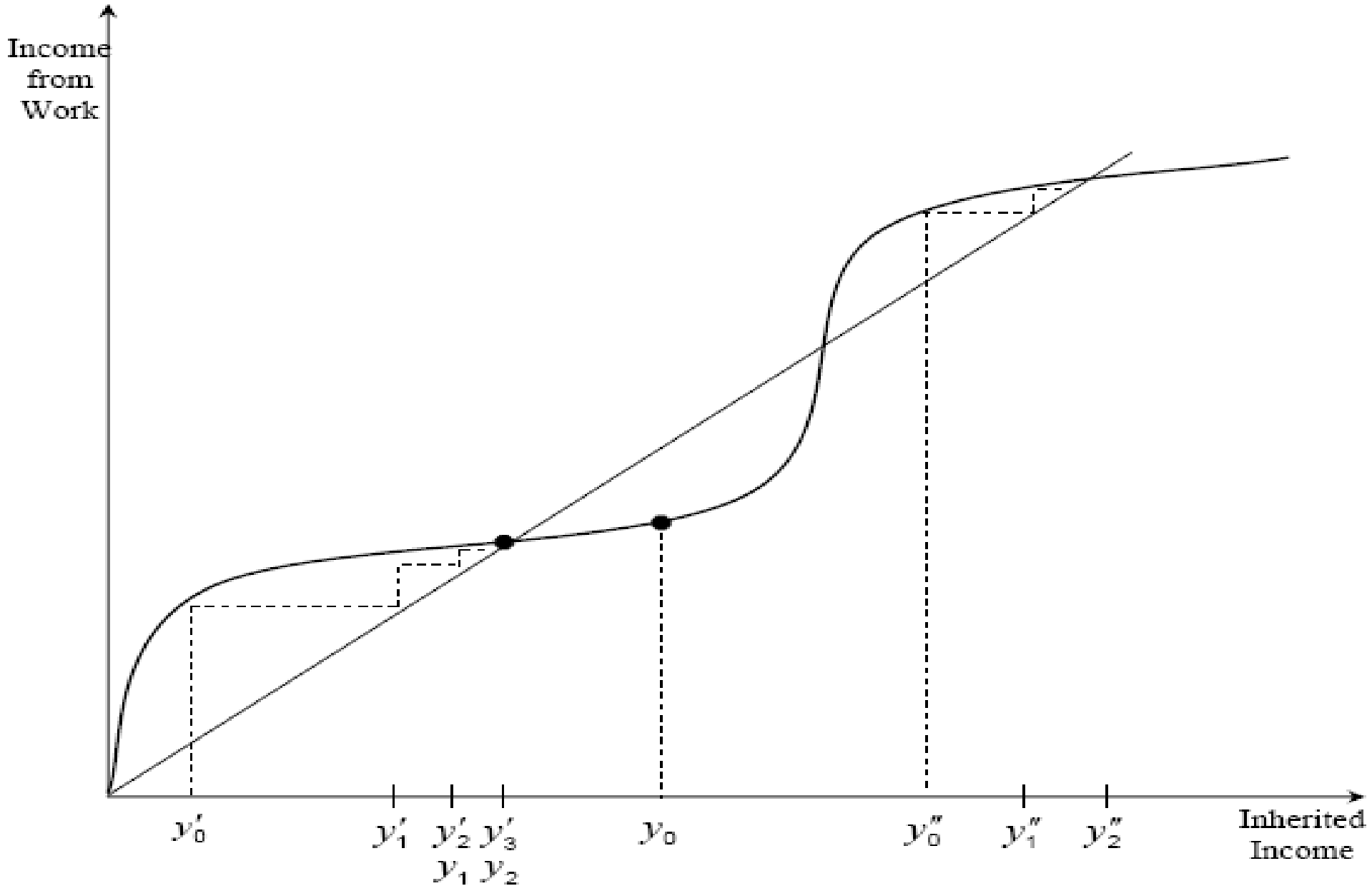


Figure 3

When Will a Poverty Trap Emerge?

- Multiple equilibria (usually interpreted as *poverty trap*) will arise iff the capacity curve intersects the 45 degree line from below (Figure 3).
- Conditions for the capacity curve to intersect the 45 degree line from below:
  - Let y^* be the point at which the capacity curve intersects the 45 degree line.
    - At this point, the derivative $\left(g\left(f\left(y^*\right)\right)\right)' > 1.$
  - Now

$$\begin{aligned}\left(g\left(f\left(y^*\right)\right)\right)' &= g'\left(f\left(y^*\right)\right)\cdot f'\left(y^*\right)\\ &= \left[\frac{g'\left(f\left(y^*\right)\right)\cdot f\left(y^*\right)}{g\left(f\left(y^*\right)\right)}\right]\left[\frac{f'\left(y^*\right)\cdot y^*}{f\left(y^*\right)}\right],\end{aligned}$$

    since $g\left(f\left(y^*\right)\right) = y^*$.

- $\left[\frac{g'\left(f\left(y^*\right)\right)\cdot f\left(y^*\right)}{g\left(f\left(y^*\right)\right)}\right]$ is the elasticity of $g\left(h\right)$ with respect to h (elasticity of income with respect to health).
- $\left[\frac{f'\left(y^*\right)\cdot y^*}{f\left(y^*\right)}\right]$ is the elasticity of f with respect to y (elasticity of health with respect to income).

- By continuity, over some range, the product of the elasticities must be greater than one.
  - A very general point which we can explore empirically.
- Elasticity is an important concept because it is unit-free: you do not need to know in what unit expenditures and calories are measured.
  - It is much easier to make comparisons across countries and samples.

2. Nutrition and Productivity: Empirical Evidence

- We have established 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 two clear empirical facts to look for:
  - the relationship between income and nutrition, and
  - the effect of nutrition on productivity.

2.1 The Relationship between Income and Nutrition

- One hidden assumption in our description of the poverty trap is that the poor eat as much as they can.
  - It would be the obvious implication of an S-shaped curve based on a basic physiological mechanism.
    - If there was any chance that by eating a bit more the poor could start doing meaningful work and get out of the poverty trap zone, then they should eat as much as possible.
- Yet, this is not what we see.
  - Most people living with less than 99 cents a day do not seem to act as if they are starving.
  - If they were, surely they would put every available penny into buying more calories; but they do not.
    - Food represents from 36 to 79 % of consumption among the rural extremely poor, and 53 to 74% among the urban extremely poor.

- It is not because all the rest is spent on other necessities.
  - In Udaipur, the typical poor household could spend up to 30% more on food than it does if it completely cut expenditures on alcohol, tobacco and festivals.
  - The poor seem to have many choices, and they don't elect to spend as much as they can on food.
- This is evident from looking at how poor people spend any extra money that they have.
  - Although they clearly have some unavoidable expenses (clothing, medicines, etc.) to take care of first, if their livelihoods depend on getting extra calories, then when a little bit more spendable money is available, it would all go into food.
    - The food budget should go up proportionately faster than total spending.
  - However, this does not seem to be the case.

2.1.1 Subramanian and Deaton (1996)

- Subramanian and Deaton (1996) provide non-parametric estimates of the relationship between total expenditures per capita in the household and calories consumed.
  - Use data on 5630 rural households from the Maharashtra state sample of the 38th round of the National Sample Survey carried out in 1983.
- Points to keep in mind:
  - Food expenditure is not equal to nutrition. (Refer to Table 1)
    - Need to go from food items consumed to nutrients consumed through conversion tables.
    - Some other adjustments needed: meals taken out or given away, waste.
  - This is not a structural relationship: it could be an income effect on the demand for food OR that the household needs more food to produce more income.
  - It is also cross-sectional: may not be a good indication of how one would react if his income increases (unobserved heterogeneity; adaptation to nutrition level).

TABLE 1

EXPENDITURE PATTERNS, CALORIE CONSUMPTION, AND PRICES PER CALORIE, RURAL MAHARASHTRA, 1983

	EXPENDITURE SHARES (%)			CALORIE SHARES (%)			PRICE PER CALORIE (Rupees per 1,000 Calories)		
	Mean (1)	Bottom 10% (2)	Top 10% (3)	Mean (4)	Bottom 10% (5)	Top 10% (6)	Mean (7)	Bottom 10% (8)	Top 10% (9)
					A. Food Groups				
Cereals	40.7	46.0	31.0	70.8	77.3	57.3	.64	.51	.79
Pulses	8.9	10.2	7.8	6.6	6.2	7.2	1.51	1.44	1.60
Dairy	8.1	4.9	11.8	2.8	1.3	4.9	3.69	3.59	3.92
Oils and fats	9.0	9.2	9.2	5.9	4.8	7.6	1.74	1.67	1.81
Meat	5.1	3.4	6.4	.7	.4	1.0	11.7	11.0	12.2
Fruits and vegetables	10.5	8.5	12.0	3.5	2.3	5.4	3.90	3.83	3.85
Sugar	6.5	7.4	5.9	7.2	7.0	8.0	1.01	.94	1.09
Other food	11.3	10.4	16.1	2.5	0.8	8.6	17.4	16.8	15.9
					B. Cereals				
Rice	11.6	9.0	10.9	15.2	10.1	16.5	.95	.89	1.02
Wheat	5.6	3.8	7.9	8.5	4.7	14.4	.79	.73	.82
Jowar	18.2	27.4	9.3	37.8	52.9	21.6	.50	.43	.55
Bajra	3.0	2.7	1.3	6.6	4.9	3.2	.48	.48	.50
Other coarse cereal	1.2	2.8	.3	2.2	4.5	.6	.66	.58	.99
Cereal substitutes	1.1	.5	1.3	.6	.2	.8	2.23	2.22	2.22
Total food (or total calories)	67.4	73.4	54.1	2,120 2,098	1,385 1,429	3,382 3,167	1.14	.88	1.50

- Estimation Method:
  - We want to estimate

$$\log \text{ (Calories per capita)} = g\left(\log \text{ (Expenditures per capita)}\right) + \epsilon.$$

    Call it $y = g(x) + \epsilon$.

  - To estimate this relationship, we use a non-parametric method: we are looking for the $g(\cdot)$ that follows as closely as possible the true shape of the function.
  - Kernel regression: Choose a grid of point for x (x_1, x_2, ...) and, at each of point x_k, compute a weighted average of y, giving more weight to the points that are closer to x_k.
  - Local Linear regression: Same method as above, but, at each point x_k, run a weighed regression, and take the predicted value. (Subramanian and Deaton use this method)
    - Advantage: with $y = \log$ (Calories per capita) and $x = \log$ (Expenditures per capita), elasticity at any point is slope of the curve: directly estimated at each point in the grid.

Results

- Figure 2 shows the local regression estimate of the regression function.
  - It shows a clear relationship between total expenditures per capita and calorie consumption.
- Figure 3 shows the slopes of the curve in Figure 2.
  - The elasticity does indeed decrease with increases in per capita expenditure.
    - But the decline is steady, from around 0.65 to 0.40 over the range shown in the figure.
- The relationship does not appear to be non-linear, at least in this range, and the elasticity is never above 1 (despite the fact that it is probably an over estimate due to the reverse causality).

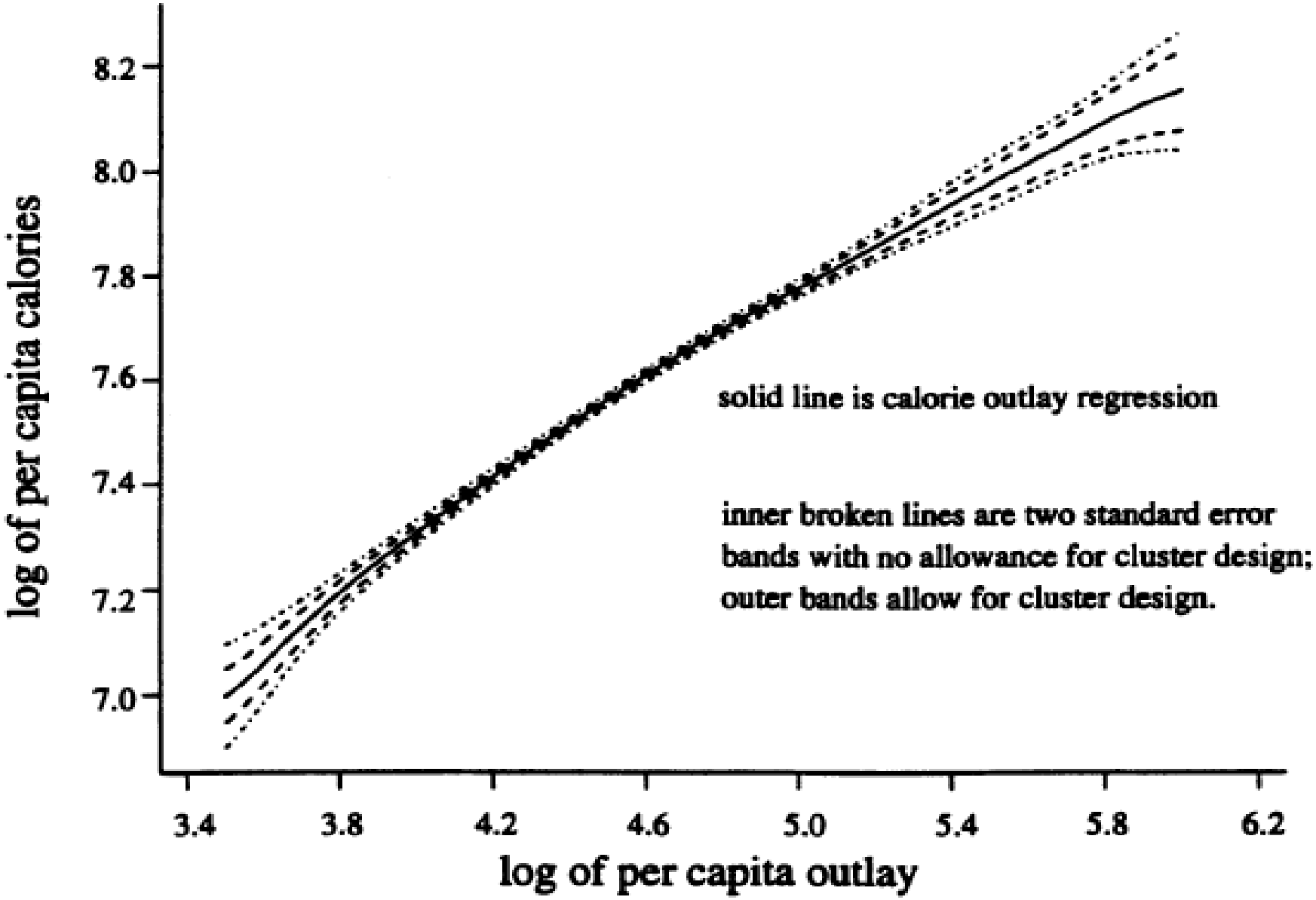


FIG. 2.—Regression function for log calories and log per capita expenditure, Maharashtra, India, 1983.

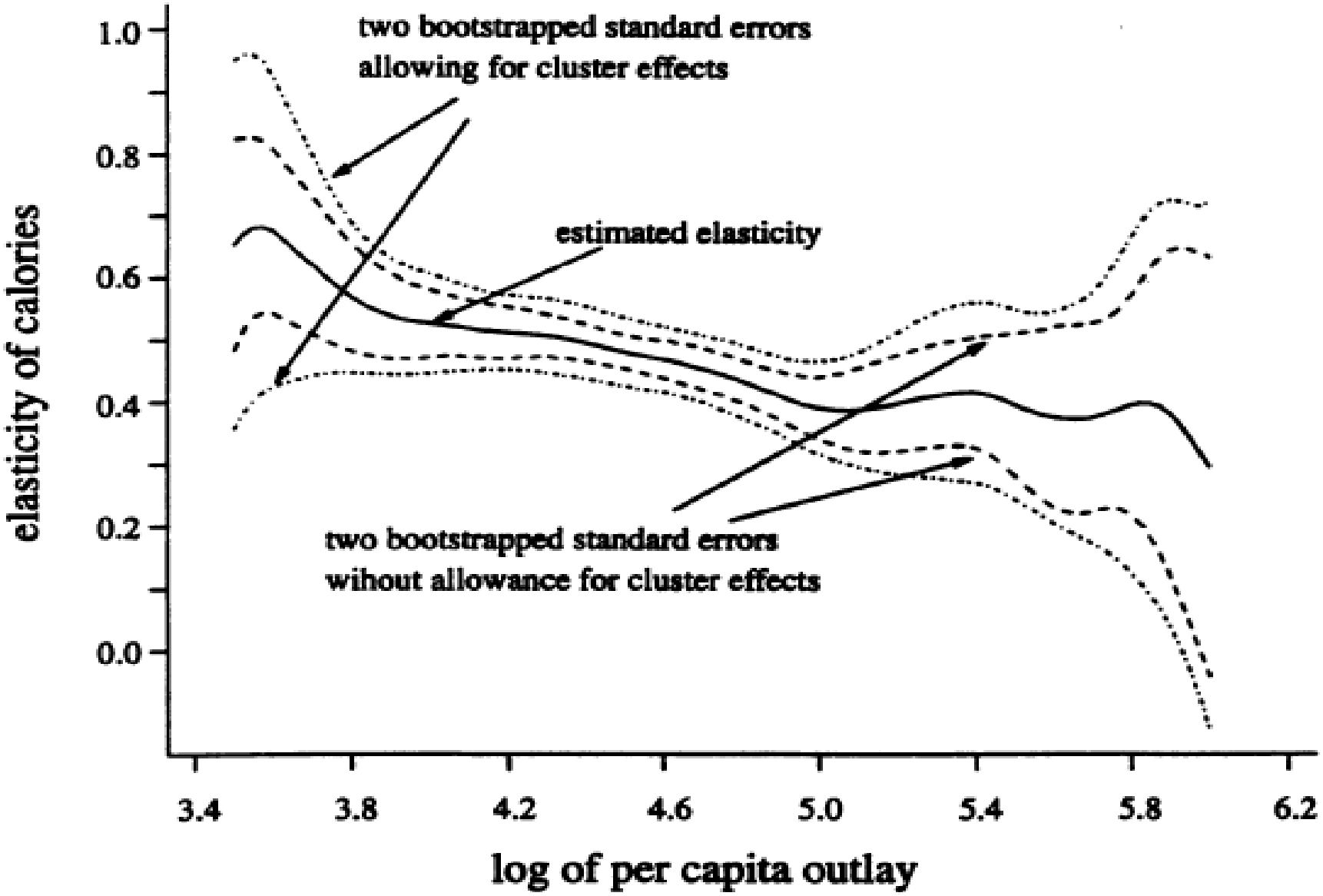


FIG. 3.—Elasticity of per capita calories to per capita expenditure, Maharashtra, India, 1983.

- So in Maharashtra, in 1983 (much before India's recent success – a majority of households then lived on 99 cents per person per day or less), even for the very poorest group,
  - a 1% increase in overall expenditure translated into about a 0.65% increase in calorie.
- Remarkably, the relationship was not very different for the poorest individuals in the sample (earning 50 cents per day) and the richest (earning around $3 per day).
- The Maharshtra case is pretty typical of the relationship between income and food expenditures the world over.
  - Even among the very poor, food expenditures increase much less than one for one with the budget.

- Figure 4 depicts price per calorie against per capita expenditure.
- This strong relationship between price of calories and expenditures indicates a lot of substitution towards more expensive calories.
  - It is not clear that households' back is against the wall, even very poor households.
- Subramanian and Deaton estimate that conditional on household size, the total expenditure elasticity of food expenditures is about equally split between the elasticity of calories and the elasticity of the price of calories.
  - A 10% increase in food expenditure is associated with a 5% increase in calorie consumption and a 5% increase in the price paid per calorie.

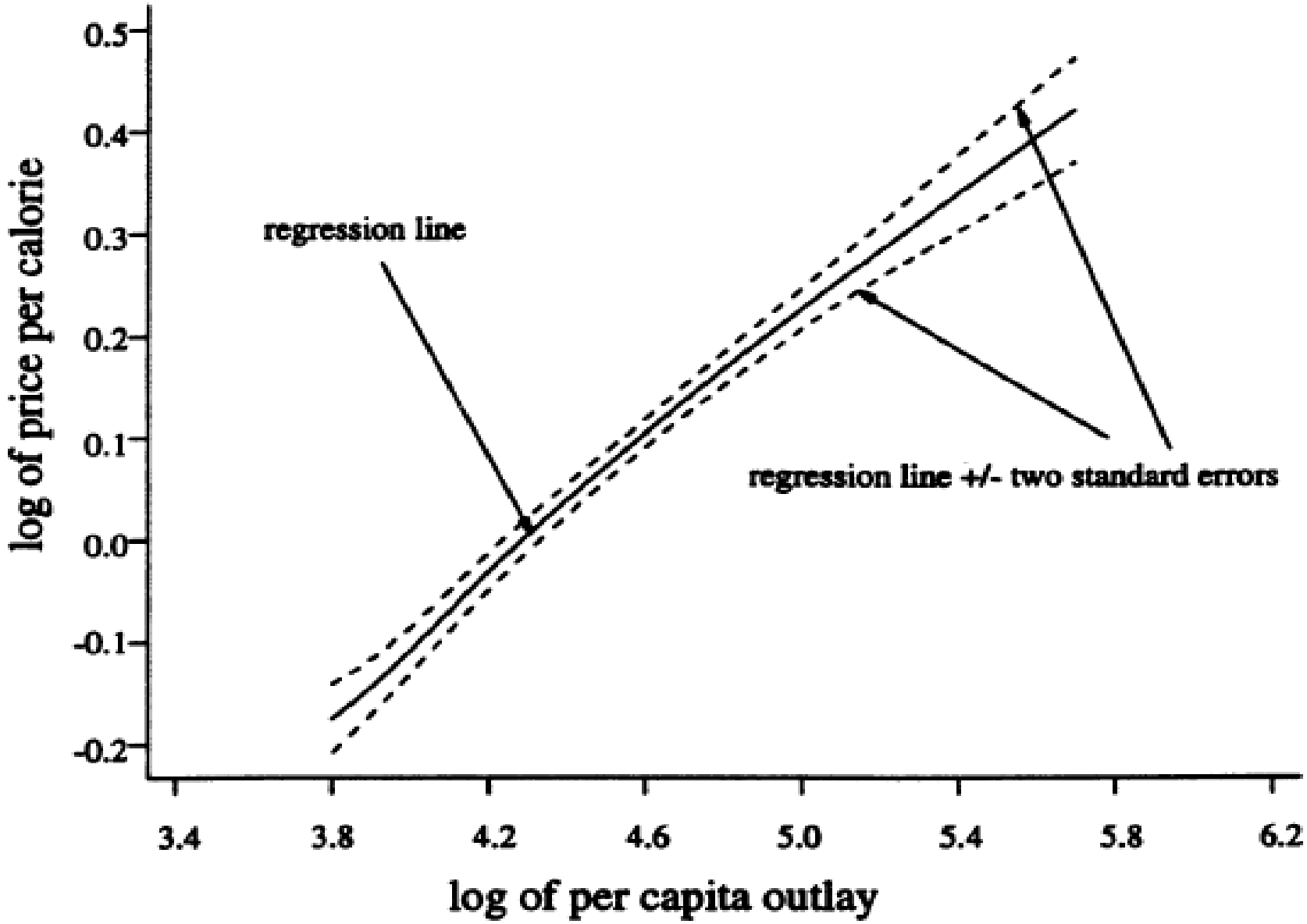


FIG. 4.—Log of price per calorie and log of per capita expenditure, Maharashtra, India, 1983.

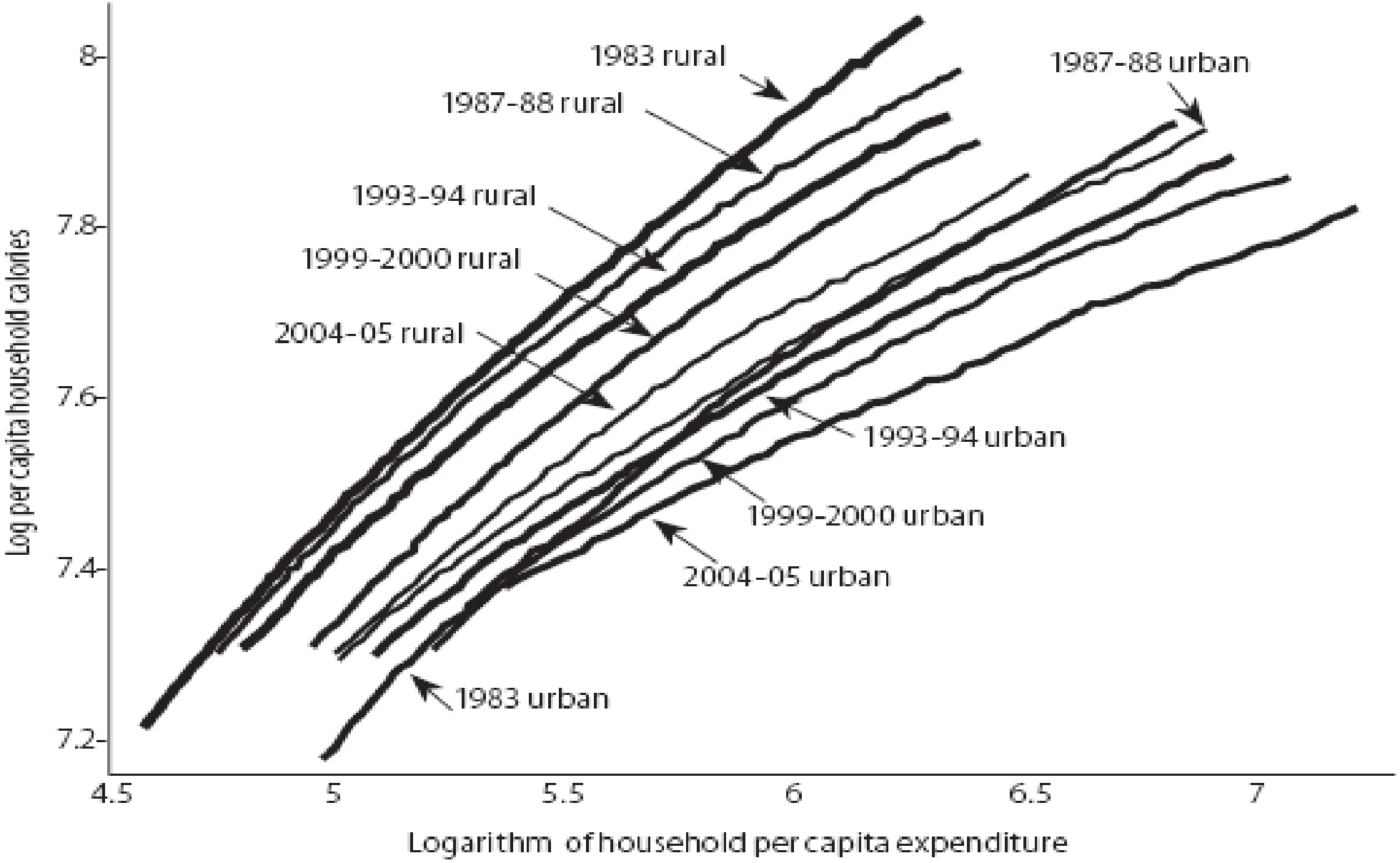
- Even the money that people spend on food is not spent to maximize the intake of calories or micronutrients.
  - When very poor people get a chance to spend a little bit more on food, they don't put everything into getting more calories.
    - Instead, they buy better-tasting, *more expensive* calories.
- Take another look at Table 1.
  - In terms of calories per rupee, jowar and bajra were clearly the best buy.
  - Yet only about two-thirds of the total spending on grains was on these grains, while another 30% was spent on rice and wheat, which cost on average about twice as much per calorie.
  - In addition, the poor spent almost 5% of their total budget on sugar.
    - But sugar is more expensive than grains as a source of calories and bereft of other nutritional values.

2.1.2 Deaton and Dreze (2009)

- Surprisingly, calorie consumption is falling down in India, at the same time as income and overall expenditure increase.
  - Despite rapid economic growth, there has been a sustained decline in per capita calorie consumption.
  - The consumption of all other nutrients except fat also have declined among all groups, even the poorest.
- Today more than 75% of the population live in households whose per capita calorie consumption is less than 2,100 calories in urban areas and 2,400 in rural areas,
  - the “minimum requirements” in India for individuals engaged in manual labour.
- At all levels of income, the share of the budget devoted to food has declined.
  - The composition of the food basket has changed;
    - the same amount of money is now spent on more expensive edibles.

- Has the Engel-curve gone away?
- No, instead it is shifting downwards over time.
  - Look at Figure 1.
- How can we reconcile an upward-slopping cross-sectional Engel-curve with a downward drifts as income increase?
- This not because of rising food prices.
  - Between the early 1980s and 2005, food prices declined relative to the prices of other things, both in rural and urban India.
  - Although food prices have increased since 2005, the decline in calorie consumption happened precisely when the price of food was going down.

Figure 1: Calorie Engel Curves, Rural and Urban India (1983 to 2004-05)



- Deaton-Dreze Explanation:
  - Calorie requirements have declined, due to better health as well as to lower activity levels.
    - Evidence: Major expansions in the availability of safe water, vaccination rates, transport facilities, the ownership of various effort-saving durables, and more sedentary work.
  - So people do not need to get enough calories to do their work, and try to get the tastier ones possible within this constraint.
- Problem with this explanation:
  - Nutritional status is still really poor in India, and not going up really fast (in NFHS some measures show a worsening of children's nutritional status).
  - This explanation assumes that people are content with a nutritional status that most of us would consider quite poor.

2.1.3 The Demand for Calories: Price Effect

- Large increase in food prices world wide since 2005.
  - From March 2007 to March 2008, the average world price for corn increased 30%; for rice, it increased 74%; for soybeans, 87%; and for wheat, 130%.
- Very concerning for the welfare of the poor.
  - Will it result in stark decline in nutritional standards?
- Note that an increase in prices will have both an income and a substitution effect (since food is an important part of the budget).
- Income effect should lead to a substitution towards cheaper food items (even if all the prices increase proportionally).

The Demand for Calories: Jensen and Miller (2008)

- Jensen and Miller (2008) found a particularly striking example of the "flight to quality" in food consumption.
- In two regions of China, they offered randomly selected poor households a large subsidy (discount vouchers) on the price of the basic staples:
  - wheat noodles in Gansu,
  - rice in Hunan.
- They made sure that the vouchers could not be re-sold and they were indeed used by the people who received them.
- We expect that when the price of something goes down, people buy more of it.
- But the opposite happened!
  - Households that received subsidies for rice or wheat consumed *less* of those two items and ate more expensive calories (shrimp and meat).

Estimation Strategy

- They regress the percent change in intake of the staple good for household i in period t on the change in the subsidy (in percent):

$$\%\Delta staple_{i,t} = \alpha + \beta \cdot \%\Delta p_{i,t} + \sum \gamma \cdot \%\Delta Z_{i,t} + \sum \delta \cdot County * Time_{i,t} + \Delta\varepsilon_{i,t}.$$

  - $\%\Delta staple_{i,t}$: percent change in household i's consumption of the staple good;
  - $\%\Delta p_{i,t}$: percent change in the price of the staple due to the subsidy;
  - $\%\Delta Z$: vector of percent changes in other control variables including
    - income (split into earned and unearned (government payments, pensions, remittances, rent, and interest from assets) sources) and household size;
  - $County * Time$: a set of county $\times$ time dummy variables.

- They refine the test by separating households by whether their Initial (preintervention) Staple Calorie Share (*ISCS*) suggests they are likely to be too poor to purchase something other than rice.

Results

- The estimation results for Hunan are presented in Table 3.
  - Column 2 (full sample with the controls) provides the first suggestive evidence of Giffen behaviour in Hunan.
  - For the group consuming at least some substantial share (20 percent) of calories from sources other than rice (columns 3 and 4), i.e., the poor-but-not-too-poor, they find very strong evidence of Giffen behaviour.
    - A 1% price increase causes a 0.45% increase in consumption, and the effect is statistically significant at the 1% level.
  - By contrast, but again consistent with the theory, the group consuming more than 80 percent of their total calories from rice (i.e., those still largely unable to consume meat), respond in the opposite direction (columns 5 and 6), with a large decline in rice consumption.
    - Since these households consume essentially only rice, they have no choice but to respond to an increase in the price of rice by reducing demand.

TABLE 3—CONSUMPTION RESPONSE TO THE PRICE SUBSIDY: HUNAN

	Dependent variable: Rice							*Dependent variable: Meat*	
	Full sample	Full sample	ISCS ≤0.80	ISCS ≤0.80	ISCS >0.80	ISCS >0.80	ISCS 0.60–0.80	Full sample	Initial intake >50g
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
%ΔPrice(rice)	0.224	0.235*	0.451***	0.466***	−0.61**	−0.585**	0.640***	−0.325	−1.125*
	(0.149)	(0.140)	(0.170)	(0.159)	(0.296)	(0.262)	(0.192)	(0.472)	(0.625)
%Δ Earned		0.043***		0.047***		0.024	0.030	0.028	0.105
		(0.014)		(0.016)		(0.023)	(0.019)	(0.050)	(0.069)
%ΔUnearned		−0.044*		−0.038		−0.058	−0.053*	0.061	0.084
		(0.025)		(0.030)		(0.049)	(0.030)	(0.079)	(0.104)
%ΔPeople		0.89***		0.83***		1.16***	0.79***	−0.08	0.03
		(0.08)		(0.09)		(0.15)	(0.14)	(0.27)	(0.36)
Constant		4.1***		5.7***		−1.8	0.8	−12.3***	−49.0***
		(1.0)		(1.1)		(1.7)	(1.3)	(3.1)	(3.7)
Observations	1,258	1,258	997	997	261	261	513	997	452
R^2	0.08	0.19	0.09	0.20	0.15	0.33	0.24	0.09	0.28

- The estimation results for Gansu are presented in Table 6.
  - Column 11 of Table 6 shows that if we examine households with ISCS in the 40%-60% range, there is evidence of Giffen behaviour, with a large elasticity (1.07), statistically significant at the 10 percent level.
  - If not as compelling as the evidence in Hunan, the results are at least suggestive of Giffen behaviour in Gansu.
- Remarkably, overall, the calorie intake of those who received the subsidy did not increase, despite the fact that their purchasing power had increased.
  - Refer to Table 2.
    - In Hunan, calories consumption actually worsens; no perceptible improvement on the other items except fat.
    - In Gansu, no change in calories consumption.

TABLE 6—CONSUMPTION RESPONSE TO THE SUBSIDY: GANSU

	Full sample (1)	≤0.70 (2)	>0.70 (3)	≤0.55 (4)	≤0.60 (5)	≤0.65 (6)	≤0.75 (7)	≤0.80 (8)	≤0.85 (9)	≤0.90 (10)	0.40–0.60 (11)	>50g meat (12)	<50g Substitute wheat (13)
%ΔPrice(wheat)	−0.353	0.024	−0.825**	−0.245	0.309	0.128	0.009	−0.280	−0.321	−0.356	1.065*	1.327*	1.106*
	(0.258)	(0.366)	(0.357)	(0.453)	(0.452)	(0.414)	(0.326)	(0.302)	(0.283)	(0.268)	(0.557)	(0.701)	(0.566)
%Δ Earned	0.079**	0.098*	0.041	−0.048	0.023	0.064	0.124***	0.107**	0.100**	0.103***	0.063	0.139*	0.156*
	(0.036)	(0.052)	(0.049)	(0.065)	(0.062)	(0.057)	(0.045)	(0.042)	(0.040)	(0.038)	(0.074)	(0.076)	(0.080)
%ΔUnearned	−0.017	−0.048	0.035	0.023	0.045	−0.007	0.005	0.063	0.034	0.009	0.189	0.059	−0.056
	(0.092)	(0.129)	(0.127)	(0.189)	(0.173)	(0.141)	(0.112)	(0.105)	(0.102)	(0.093)	(0.181)	(0.147)	(0.172)
%ΔPeople	0.58***	0.34	0.80***	0.18	0.25	0.24	0.40	0.42*	0.42*	0.53**	0.11	1.70***	0.45
	(0.22)	(0.30)	(0.25)	(0.41)	(0.34)	(0.32)	(0.27)	(0.25)	(0.23)	(0.22)	(0.32)	(0.23)	(0.29)
Constant	−26.1***	−20.8***	−32.8***	−18.7***	−19.5***	−20.3***	−22.9***	−23.3***	−25.8***	−25.7***	−31.6***	0.82	−26.8***
	(2.3)	(3.3)	(2.9)	(4.5)	(4.1)	(3.7)	(3.0)	(2.7)	(2.6)	(2.4)	(4.4)	(5.1)	(5.5)
Observations	1269	687	582	406	478	563	843	995	1107	1199	266	107	247
R^2	0.08	0.11	0.09	0.17	0.14	0.12	0.09	0.10	0.08	0.08	0.24	0.33	0.22

Table 2. Calorie Response to the Price Subsidy

	HUNAN					GANSU				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Full Sample (Calories)	Below Median (Calories)	Above Median (Calories)	Bottom Quartile (Calories)	Full Sample (Protein)	Full Sample (Calories)	Below Median (Calories)	Above Median (Calories)	Bottom Quartile (Calories)	Full Sample (Protein)
%Subsidy(rice/wheat)	-0.206*	-0.042	-0.339**	0.004	-0.096	0.154	0.169	0.132	0.070	0.091
	(0.108)	(0.144)	(0.164)	(0.207)	(0.133)	(0.100)	(0.143)	(0.138)	(0.261)	(0.112)
%ΔEarned	0.031***	0.026*	0.036**	0.037*	0.040***	0.028**	0.027	0.029	0.053	0.017
	(0.011)	(0.014)	(0.018)	(0.021)	(0.013)	(0.014)	(0.021)	(0.019)	(0.034)	(0.016)
%ΔUnearned	-0.022	-0.025	-0.023	-0.037	-0.010	0.046	0.020	0.071*	0.101	0.069
	(0.020)	(0.027)	(0.028)	(0.034)	(0.023)	(0.035)	(0.056)	(0.043)	(0.119)	(0.033)
%ΔPeople	0.94***	1.07***	0.80	1.04***	0.93***	0.91***	1.01***	0.81***	1.08***	0.88***
	(0.07)	(0.08)	(0.11)	(0.10)	(0.07)	(0.08)	(0.10)	(0.12)	(0.13)	(0.09)
Constant	0.9	1.6	0.5***	2.8*	0.8	-1.9	0.1	-3.9	0.6	-4.0
	(0.8)	(1.1)	(1.1)	(1.5)	(0.9)	(0.8)	(1.1)	(1.1)	(1.7)	(0.9)
Observations	1258	633	625	317	1258	1269	634	635	320	1269
R^2	0.26	0.34	0.21	0.39	0.20	0.18	0.23	0.15	0.29	0.16

- The likely explanation is that because the staple formed such a large part of the household budget, the subsidies had made them richer.
  - If the consumption of the staple is associated with being poor (say, because it is cheap but not particularly tasty), feeling richer might actually have made them consume *less* of it.
- Once again, this suggests that at least among these very poor urban households, getting more calories was not a priority;
  - getting better-tasting ones was.

2.1.4 Income and Nutrition: Conclusion

- The poor do not seem very hungry for extra calories.
  - The elasticity of calorie consumption with respect to income is relatively low (Subramanian and Deaton's maximum estimate is just 0.65).
    - However, even this may be an overestimate, since this does not take into account difference between people, or endogeneity.
- The results of the Jensen and Miller experiment suggests that the income effect on calories may even be negative in some context!
- A priori, all these should already make us a bit suspicious that there cannot be a poverty trap based on nutrition:
  - if they could step outside of the poverty trap just by eating more, they would.

2.2 The Effect of Nutrition on Productivity

- If most people are at the point where they are not starving, it is possible that the productivity gains from consuming more calories are relatively modest for them.
  - It would then be understandable if people choose to do something else with their money, or move away from eggs and bananas toward a more exciting diet.

2.2.1 Calories and Productivity: Strauss (1986)

- Strauss (1986) investigates the effect of calorie consumed on the productivity of labour.
- He settles on self-employed farmers in semi-arid Sierra Leone.
  - Since these farmers have to work very hard, we would expect the strongest effect of calories on productivity.
- Ideally we would like to regress productivity on calories consumed.
  - But *endogeneity* is the obvious problem.
- Strauss (1986) solves the problem by using an *instrument*.
  - The basic idea is to regress calorie on the price of food, and then regress individual "log (productivity)" on the "log (predicted calories)".
    - He does find that in Sierra Leone, people eat less calories when the price of food goes up.

- Strauss (1986) finds a fairly strong relationship between calories and productivity with a maximum elasticity of 0.4.
  - Even if people double their calorie consumption, their productivity would only increase by 40%.
- If we go back to the calculations we made earlier:
  - product of the highest possible elasticities $= 0.4 \times 0.65 \approx 0.26$, much less than 1.
  - Thus the Dasgupta and Ray (1986) mechanism does not seem to be at play, for most people, in most regions.
- Furthermore, the shape of the relationship between calories and productivity is not an S-shape, but an inverted L-shape curve. (Refer to the following Figure 2)
  - The largest gains are obtained at low levels of food consumption; there is no steep jump in productivity once people start eating enough.
  - Recall that this is precisely the type of situation where we would not see a nutrition-based poverty trap.

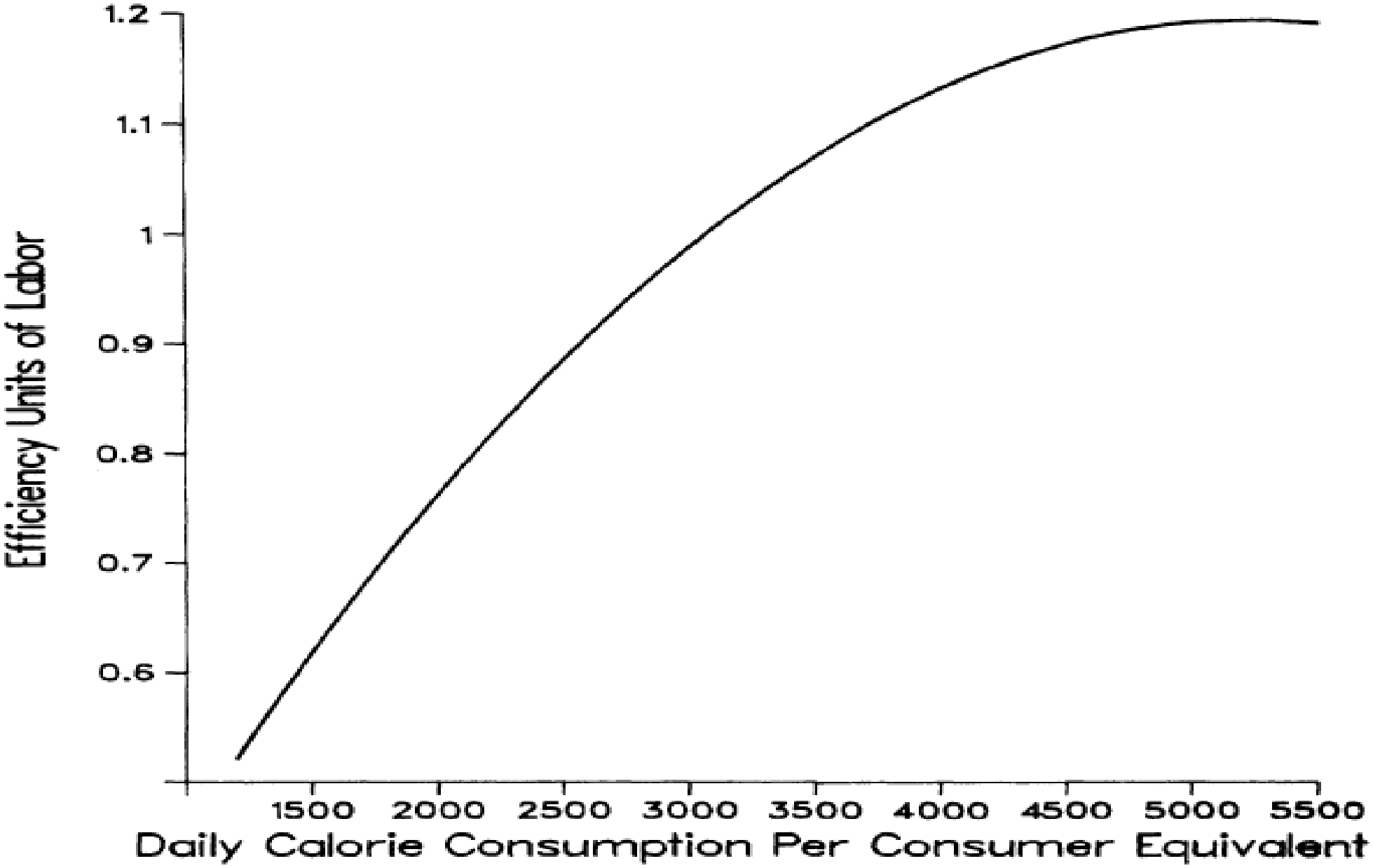


FIG. 2.—Estimated efficiency labor function

- This is not to say that the logic of the hunger-based poverty trap is flawed.
  - The idea that better nutrition would propel someone on the path to prosperity was almost surely very important at some point in history, and it may still be important in some circumstances today.
- **Fogel (2004)** calculates that in Europe during the Renaissance and the Middle Ages, food production did not provide enough calories to sustain a full working population.
  - This could explain why there were large numbers of beggars – they were literally incapable of any work.
- **Oster (2004):** The pressure of just getting enough food to survive seems to have driven some people to take rather extreme steps.
  - There was an epidemic of "witch" killing in Europe during the mid-sixteenth century to 1800, when crop failure were common and fish was less abundant.
  - Witches were most likely to be single women, particularly widows.

- Evidence that poor families might occasionally be forced to make such horrific choices is not hard to find even in more recent times.

- **Rose (1999):** During droughts in India in the 1960s, little girls in landless households were much more likely to die than boys (although boys' and girls' death rates were not very different when there was normal rainfall).

- **Miguel (2005):** Tanzania experiences a rash of "witch" killings whenever there is a drought – a convenient way to get rid of an unproductive mouth to feed at times when resources are very tight.

  – Families suddenly discover that an older woman living with them (usually a grandmother) is a witch, after which she gets chased away or killed by others in the village.

2.2.2 Nutrition and Productivity: Other Nutrients

- There are other forms of micro-nutrient deficiency causing undernutrition.
- One very frequent one is iron deficiency causing anemia.
  - Anemia is associated with low aerobic capacity, general weakness and lethargy, and in some cases (especially for pregnant women) it could be life-threatening.
- The Work and Iron Status Evaluation (WISE) study in Indonesia provided randomly chosen men and women in rural Indonesia with regular iron supplementation for several months,
  - while the comparison group received a placebo.
- The study found that the iron supplements made the men able to work harder;
  - the resulting increase in their income was many times the cost of a yearly supply of iron-fortified fish sauce.
    - A year's supply of the fish sauce cost $7 USD PPP, and, for a self-employed male, the yearly gain in earnings was $46 USD PPP.

2.2.3 Nutrition During Childhood

- Nutrition during adulthood is in large part a short term investment: eat better today, be more productive tomorrow.
- However, nutrition during childhood is likely to be a long term investment.
  - There is a lot of evidence for the general view that childhood malnutrition directly affects the ability of adults to function successfully in the world.
- **Baird, Hicks, Kremer and Miguel (2010):**

  In Kenya, children who were given deworming pills in school for two years as compared to children in comparable schools who received deworming for just one year,
  - went to school longer and earned 20% more as young adults.
    - Worms contribute to anemia and general malnutrition, essentially because they compete with the child for nutrients.

2.2.4 Nutrition in Utero

- There is now a growing body of literature to show that conditions of life in utero affect outcome throughout life.
- **Field, Robles and Toreo (2009):** In Tanzania, there was an intermittent government programme of distributing iodine capsules to would-be mothers.
  - Children who were born to mothers who received sufficient amounts of iodine during pregnancy completed between one-third and one-half year more schooling,
    - compared to their younger and older siblings who were in utero when the mother was not getting these capsules.
  - Half a year of education is a substantial increase given that most of these children will complete only four or five years of schooling.
  - Based on their estimates the study concludes that if every mother were to take iodine capsules, there would be a 7.5% increase in the total educational attainment of children in Central and Southern Africa.

3. Conclusion

- Is there really a nutrition-based poverty trap?
- Our reading of the evidence suggests that most *adults*, even the very poor, are outside of the nutrition poverty trap zone.
  - They can easily eat as much as they need to be physically productive.
- But this does not mean that nutrition is not a problem for the poor.
  - The problem may be less the quantity of food than its quality, and, in particular, the shortage of micro-nutrients.
  - The benefits of good nutrition may be particularly strong for two sets of people who do not decide what they eat:
    - unborn babies and young children.

- There may well be an S-shaped relationship between their parents' income and the eventual income of these children, caused by childhood nutrition.
  - That is because a child who got the proper nutrients in utero or during early childhood will earn more money *every year of his or her life*.
    - This adds up to large benefits over a lifetime.

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