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# Why does asset inequality affect unemployment?*

## A study of the demand composition problem

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*Abstract:* This paper is devoted to a general equilibrium analysis of the relationship between the inequality in asset holdings and the aggregate levels of output and employment in a developing economy. Since luxuries and basic goods compete for the use of the same scarce resources, unemployment is conceived as a mechanism whereby the market demand for basic goods can be limited to a sufficiently low level so that the high demand for luxuries can be met. The ambiguous effects of capital accumulation on employment are also examined.

### 1. Introduction

The purpose of this paper is two-fold. First, we conduct a general equilibrium analysis of the relationship between the inequality of asset holdings and the aggregate levels of output and employment in a developing economy. Of course, there are many aspects to this relationship. We focus on only one, which might be called the *demand composition problem.* This problem is concerned with the following causal chain: inequality in the distribution of endowments creates a high demand for luxury products. These products compete with basic needs for the use of scarce resources, restricting the supply of the latter type of products. Given this scarcity, the

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market clears by reducing the amount of employment in the economy. The creation of unemployment might be regarded as a way of keeping the market demand for basic needs suitably low, thereby permitting the high demand for luxuries to be met. This problem is clearly related to the more general notion of social disarticulation [see de Janvry (1981) and de Janvry and Sadoulet (1983)].[1]

The second purpose of this paper is to tie up the demand composition problem with a related set of issues studied most notably by Kalecki (1976). Kalecki was concerned with the forces that limit employment generation in a developing economy. One limitation certainly stems from the fact that the available technology of production simply cannot accommodate more than a certain quantity of labour. This has been referred to as *structural unemployment* [see Eckaus (1955) for an early but illuminating discussion] or as the *technology constraint* [see Sen (1975)]. Kalecki, however, emphasized a different set of constraints, namely those imposed by the shortage of food, or more generally, basic needs. Given a fixed supply of food in the economy and a fixed wage per worker, there is an upper bound to the amount of employment that can be generated. This is the *consumption constraint* [see Sen (1975)]. According to Kalecki, a rise in employment may result from an increase in the supply of food or from a fall in the wages of the existing workers [see also Rao (1958), Sen (1975) and Rakshit (1982) for related discussion].

This literature did not, however, inquire into the determinants of the *supply* of basic needs. Given the overall endowment of resources, the availability of basic needs depends crucially on the composition of demand generated in the economy, and therefore, at a more basic level, on the existing distribution of asset ownership. The market can react to the existing demand composition in two ways. First, the allocation of resources between the basic and the non-basic sectors can be altered. Second, the basic needs output itself may be funnelled away for non-basic uses. This second channel has been explored empirically in the context of the 'food–feed controversy' [see, for example, Yotopoulos (1985)]. We emphasize this route in our paper, though the first channel is no less important.[2]

The particular model that we study is similar to the general equilibrium models in Dasgupta and Ray (1986, 1987), but amended substantially to allow for the presence of demand effects, our major object of analysis. We consider a static economy in which three commodities are produced: a basic

[1]Of course, a natural question is: why do *prices* not adjust, instead of quantities? The paper addresses this issue directly; the patient reader must await the full development of the model.

[2]One need not only study the food supply as the only example of a basic item. Another situation to which this set of issues applies equally well is the question of primary education versus higher education. In such a model, it may be more natural to emphasize the first route discussed above.

needs item called food, a mass consumption industrial item called clothing, and a luxury product called meat. Food is produced using land and efficiency units of labour. Clothing is produced using capital and labour. Meat is produced with food.[3] The production of all commodities is carried out on a profit maximizing basis. Food creates labour power,[4] but after some minimal level of its consumption, is not valued for its own sake. Provided that this minimum has been attained, agents seek to maximize a utility function defined on clothing and meat, subject to whatever residual income is available. Each individual supplies all the labour power he possesses in an inelastic way, and owns an exogenously given amount (perhaps zero) of land and capital.

It turns out that the competitive equilibria of these models are often associated with less than full-employment, even though there may exist enough resources to employ all and feed all adequately. Similar equilibria have been explicitly studied in static models by Dasgupta and Ray (1986, 1987) and in dynamic models by Ray and Streufert (1988). Our primary interest here is to study how the macroeconomic features of competitive equilibria are altered by changes in asset inequality via the composition of demand. In addition, we also study the effects of capital and land accumulation, as the basic method used is very similar.

In section 2, we describe the framework of our analysis. In section 3, we describe our notion of equilibrium and the various features yielded by this notion in our model. We note that our equilibrium does not correspond to the standard Walrasian concept, but nevertheless that it is Pareto-optimal, *even when it displays involuntary unemployment*. It follows that every short-run policy to lower unemployment in this model *must* involve an element of redistribution. In section 4, we conduct the main exercise for a particular equilibrium regime. This is done informally, with all formal analysis relegated to the appendix. We find that equilibrium unemployment is directly related to the inequality of asset holdings. Furthermore, the same sort of analysis permits us to conclude that capital accumulation has *negative* effects on employment, under some plausible assumptions. This is to be contrasted with the accumulation of land (equivalently, capital formation in the basic goods sector), which has salutary effects on employment. As we take some pains to point out the intuition underlying these results in the process of deriving them, we shall not repeat ourselves here. Finally, the appendix complements the non-technical main text by formally describing some aspects of the

[3]This last production function is particularly simple, designed to emphasize the direct competition between luxuries and basics. The food input into the production of meat may be interpreted as fodder for cattle. See Yotopoulos (1985) for an illuminating analysis of the relative amounts of food devoted to direct consumption and to fodder.

[4]This is the familiar nutrition-efficiency curve used in Leibenstein (1975a, b), Mirrlees (1975), Bliss and Stern (1978a), Stiglitz (1976) and Dasgupta and Ray (1986, 1987), among others.

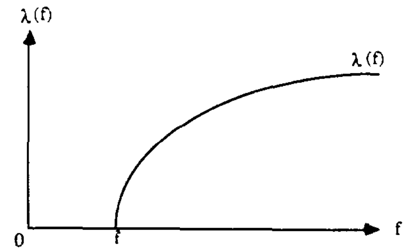


Fig. 1. The conversion function $\lambda(\cdot)$.

equilibrium concept, by proving the results of section 4, and by extending these results to the other equilibrium regime of interest.

## 2. Basic framework

### *2.1. Commodities*

Consider an economy endowed with a fixed amount of land ($T$) and capital ($K$). Three consumption goods are produced in this economy:

(1) *A basic needs item*, which we shall call *food* ($f$). Food is produced using land and efficiency units of labour ($e_f$) as inputs. The production function for food, $F(T, e_f)$, is taken to be constant returns to scale, increasing, differentiable, strictly concave in each input and satisfying the Inada end-point conditions.[5]

Food enters into the creation of efficiency units. Upon the consumption of $f$ units of food, a worker obtains $\lambda(f)$ units of efficiency units of labour which he supplied inelastically on the labour market. Call this function $\lambda(\cdot)$ the *conversion function*. We describe $\lambda(f)$ in fig. 1.

We assume that $\lambda(f)=0$ for $f \in [0,\hat{f}]$, where $\hat{f}>0$, that $\lambda(f)$ is strictly increasing and differentiable for $f>\hat{f}$, that $\lambda$ is continuous at $\hat{f}$ and that $\lambda$ is concave on the restriction $[\hat{f}, \infty]$, with $\lambda'(f)\to\infty$ as $f\to\hat{f}$.

(2) A *mass consumption item*, which we shall call *clothing* ($c$). It is produced using capital and efficiency units of labour, according to a production function $C(K, e_c)$. Assume that $C(K, e_c)$ is constant returns to scale, increasing, differentiable, strictly concave in each input and satisfying the Inada end-point conditions.

(3) A *luxury item*, which we shall call *meat* ($m$). We wish to emphasize the substitutability between luxuries and basic needs. To do so, we assume that

[5] Inada-type assumptions are only made to guarantee interior solutions, so that technical problems are minimized. They are in no way necessary for the results. The same remark holds for the corresponding assumptions made on the mass-consumption good production function (see below).

meat production is carried out with food as the only input, using a linear production function[6] $m=\omega f$, where $\omega>0$. We assume that meat does not contribute to the creation of efficiency units.

### 2.2. *The distribution of assets*

We assume that there are a large number of competitive agents in the economy, indexed by $n\in[0,1]$. All agents are presumed identical, in that they have the same conversion function of food into effort, and the same preferences. However, they differ in their asset ownership. Denote by $t(n)$ and $k(n)$ the ownership of land and capital by person $n$. Of course, remembering that $T$ and $K$ represent aggregate availabilities of land and capital, we have $\int t(n)=T$ and $\int k(n)\,\mathrm{d}n=K$. Finally, define person $n$ to be *assetless* if $t(n)=k(n)=0$.

### 2.3. *Agent preferences*

We now turn to a description of the (identical) preferences of agents. In doing so, we shall make more precise the notions of basics, mass consumption goods and luxuries, which we introduced in section 2.1.

(1) First, each agent endeavours to reach a *subsistence level* of food consumption, *before* consuming any quantity of any other good. We link this notion of subsistence in a natural way to the conversion function by equating the subsistence level to $\hat{f}$, which is the threshold after which $\lambda(\hat{f})>0$. An agent who fails to consume $\hat{f}$ will be called *undernourished.*

Apart from this lexicographic insistence on attaining a subsistence level, it is assumed that the agent's interest in food is purely 'functional', in the sense that more food will be consumed only to improve the agent's market command over *other* commodities (see below).

The primacy of food that we have postulated above justifies our use of the term *basic good* for it.

(2) An agent who can consume the subsistence level of food may look further. We assume that he maximizes a utility function $U(c,m)$, defined on clothing and meat, subject to the maximum amount of 'residual income' available after meeting subsistence. Assume that both clothing and meat are normal goods.

[6]In the spirit of the nomenclature we are using, the use of this production function is not difficult to justify. Food supplies are typically diverted as fodder for cattle to produce meat [see e.g., Yotopoulos (1985)]. More generally, we wish to capture the fact that luxuries may compete directly with basic needs for certain scarce resources. In this model, the scarce resource of land. In the possible analogy with education discussed in footnote 2, the scarce resource may correspond to the supply of trained teachers, or to physical resources for educational purposes that are inelastically fixed in the short run.

An additional specification on the utility function will be needed to capture the fact that meat is a 'luxury'.

(3) Meat is a luxury in the following sense: we postulate that for every fixed price vector of $(c,m)$, the utility maximizing *budget share* of meat increases with residual income (see Appendix A.4), with the minimum budget share of meat strictly positive.

This completes our description of agent preferences.

### 2.4. The budget constraint and agent behaviour

We normalize so that the price of clothing is always unity. Let the wage rate (per efficiency unit) be $v$, the rental rate be $r$, the rate on capital $\rho$, the price of food $p$, and the price of meat $q$. The *price vector* $\pi$ is the collection $(p,q,v,r,\rho)$.

Consider an agent with *non-labour income* equal to some value, $R$.[7] His budget constraint permits him to choose all combinations $(e,f,c,m)\geqq 0$ with

$$e=\lambda(f) \tag{1}$$

and

$$pf+qm+c\leqq ve+R. \tag{2}$$

*It may be that the constraints (1) and (2) do not permit the agent to reach the subsistence level $\hat{f}$.* Such an agent will be called *non-viable.*[8] Fig. 2 illustrates.

An excluded agent cannot sell any efficiency units on the labour market, for these require a food consumption level he cannot afford. An excluded agent simply uses his non-labour income, if any, to nourish himself as far as possible.

We turn now to the *viable agent*, i.e., an agent for whom subsistence *is* assured by his budget constraint. Fig. 3 illustrates. Observe from the diagram that a viable agent is always in a position to sell efficiency units in the labour market.[9]

Nevertheless, a viable agent may be denied access to the labour market. Such an agent will be called *involuntarily unemployed.* The use of this term should not be controversial. A viable agent who cannot obtain a job is *able* to work. Moreover, the act of employment certainly makes him strictly better off. At the very least, it affords him higher food consumption and greater labour power.

[7]Presently, we shall write $R$ explicitly as a function of the agent's asset holdings.

[8]In this model, we do not model the dynamic process by which a non-viable agent progressively runs down economic and nutritional stores to maintain himself over time. See Ray and Streufert (1988) and Dasgupta and Ray (1988).

[9]To be precise, this observation stems from our assumption that $\lambda'(0)=+\infty$.

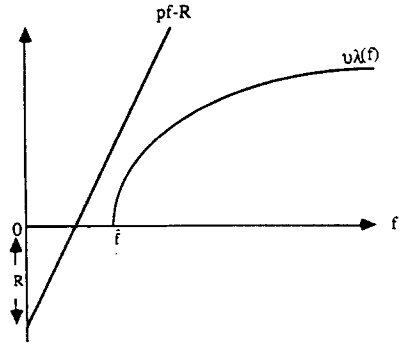


Fig. 2. The non-viable agent.

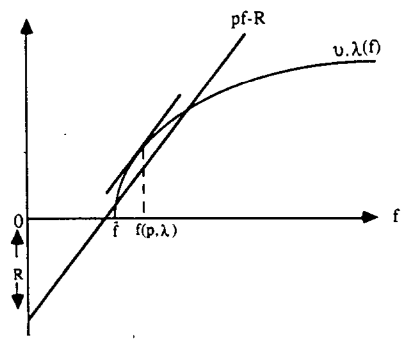


Fig. 3. The viable agent.

An involuntarily unemployed person must make do with his non-labour income, just as the non-viable agent does.

We will sometimes refer to the collective group of the non-viable and the involuntarily unemployed as the *unemployed.*

Finally, consider the viable, employed agent. It is easy to deduce his food consumption and the number of efficiency units he will supply. Examine fig. 3, together with the budget constraints (1) and (2). It is easy to see that the *highest residual income* (net of money spent on food) is attained by maximizing the difference between $v\lambda(f)$ and $pf$, in the variable $f$ (for $f \geqq \hat{f}$). A standard first-order condition, illustrated in fig. 3, reveals that this food consumption $f(p,v)$ is given by the identity

$$v\lambda'(f(p,v)) \equiv p. \tag{3}$$

Observe that this food consumption is independent of the actual value of the non-labour income of the agent, as long as the latter is sufficient to guarantee viability.

The viable, employed agent's best residual income is found by adding his non-labour income, $R$, to the surplus $[v\lambda(f)-pf]$. This is used to buy $(c,m)$ according to the utility function $u(c,m)$.

### 2.5. *Non-labour income*

We have described agent *consumer* behaviour. Just as in the Arrow–Debreu framework, agents *qua* producers maximize profits at the going price vector $\pi$. Clearly, given our assumption of constant returns to scale, all profits will be zero in equilibrium. Consequently, the non-labour income of agent $n$ is simply

$$R=rt(n)+\rho k(n). \tag{4}$$

This completes our description of the model.

## 3. Equilibrium

### 3.1. *Definition*

Our notion of an equilibrium is *necessarily* non-Walrasian, in a sense that we shall make clear below (sections 3.2 and 3.4). Here are the defining features.

An *equilibrium* is a collection of (a) a price vector $\pi^*$, (b) an allocation of commodities and labour which we shall denote with star superscripts, *and* (c) a set of employed people $G^*\subseteq[0,1]$ satisfying the following conditions:

(1) *Profit maximization and full employment of non-labour inputs:*

$$p^*F_e(T,e_f^*)=v^*, \quad C_e(K,e_c^*)=v^*, \tag{5}$$

$$p^*F_t(T,e_f^*)=r^*, \quad C_k(K,e_c^*)=\rho^*, \tag{6}$$

$$q^*=\omega p^*. \tag{7}$$

Eqs. (5)–(7) characterize profit maximization *and* the condition that land and capital must be fully employed. This part of the equilibrium condition is unreservedly Walrasian.

(2) *Labour market equilibrium*: The set of employed people $G^*$ satisfies the following conditions. First,

$$n\in G^* \text{ implies } n \text{ is viable at the price vector } \pi^*. \tag{8}$$

That is, all employed people must be *capable* of employment, as defined above. Second, we require that $G^*$ supplies the total labour requirements at the equilibrium prices:

$$e_f^* + e_c^* = \lambda(f(p^*, v^*))\mu(G^*), \tag{9}$$

where $\mu(G^*)$ is the measure of $G^*$ ('number' of people in $G^*$) and $\lambda(f(p^*, v^*))$ is, of course, the number of efficiency units supplied by each viable employed agent.

Third, we allow for our fundamental non-Walrasian feature, involuntary unemployment. It will turn out that $G^*$ will, in general, *not* contain *all* the viable agents. The excluded viable agents are the involuntarily unemployed. *However, it is a precondition of our equilibrium that no viable unemployed agent must be able to undercut the going wage and remain viable.* This feature is our final restriction on $G^*$.

$$n \notin G^* \rightarrow n \text{ is not viable at any } (p^*, q^*, r^*, v, \rho^*) \quad \text{with} \quad v < v^* \tag{10}$$

(3) *Commodity market equilibrium*: Our final set of equilibrium conditions states that the supply of each of the three commodities – food, clothing and meat – must equal its demand at the price vector $\pi^*$. We omit a formal statement in the main text, as it necessitates some complicated notation. See Appendix A.3 for a precise statement.

### 3.2. *Different equilibrium regimes*

An equilibrium may display one of three possible features, and we use these to divide the entire set into three *regimes*.[10]

#### 3.2.1. *Unemployment of the assetless*

In such an equilibrium regime, the set of employed people includes *all* asset owners and part of the assetless labour force. However, another part of the assetless labour force is left unemployed. Fig. 4 below indicates how this comes about.

We must note an important characteristic of this regime. At the equilibrium prices *all* the assetless agents are viable (see fig. 4). However, all the assetless cannot be *simultaneously* employed because there just is not enough demand for labour at the going prices. However, the wage rate cannot fall because it is obvious from fig. 4 that in that case, *no* assetless agent remains viable. *Consequently, in such a regime, a standard Walrasian equilibrium does not exist.* This is best seen by observing that in our equilibrium, there is

[10]These observations closely parallel similar discussions in Dasgupta and Ray (1986), so we shall be quite brief. We also exclude a proof of the existence of equilibrium.

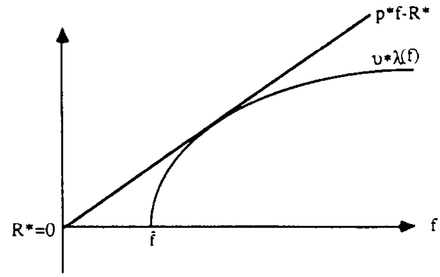


Fig. 4. Regime 1 equilibrium. The just-employed agent is assetless.

*unequal* treatment of ex-ante *identical*, assetless agents. Some are employed, some are not. This unequal treatment – 'involuntary unemployment' – is inconsistent with the Arrow–Debreu framework.

Note also that the assetless unemployed are undernourished in such an equilibrium, and that the assetless employed agents receive the standard 'efficiency wage', i.e., their income in food units is precisely the solution to the problem

$$\min_{f > \hat{f}} f/\lambda(f). \tag{11}$$

*3.2.2. Unemployment of asset-owners*

In the second regime, all the assetless as well as some of those with 'small' amounts of lands and capital are unemployed and undernourished. Fig. 5 shows us the 'borderline' viable asset-owner.

All asset-owners with a higher value of assets are employed. All types with lower asset values (including, of course, the assetless) are unemployed. Involuntary unemployment is thus conceived of as a discontinuity of the income schedule as a function of types [Dasgupta and Ray (1986)].

All employed agents supply the same number of efficiency units of labour. Unlike their total income, their wage incomes are therefore all the same; though, of course, their employment is certainly conditional on their asset position.[11] Finally, the wage rate can be seen to be *less* than the standard efficiency wage.

*3.2.3. Full employment*

In this regime, all agents are employed, and there is no undernutrition. The wage rate is at least as high as the standard efficiency wage. Fig. 6

[11]Note the difference between this model and the one in Dasgupta and Ray (1986). There, wage incomes are not equalized. We have deliberately constructed our model to de-emphasize these results and focus more fully on the demand side of the picture.

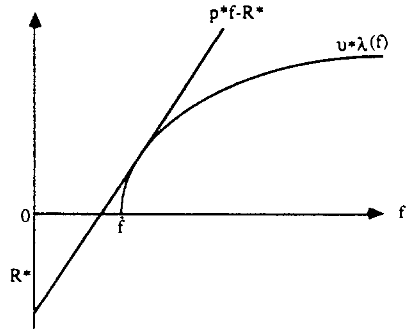


Fig. 5. Regime 2 equilibrium. The just-employed agent has some assets.

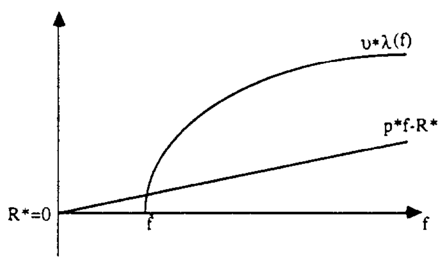


Fig. 6. Regime 3 equilibrium. Full-employment prevails.

illustrates this by showing that even the assetless are viable with room to spare.

### *3.3. Regimes, aggregate stocks, and inequality*

There is a complex relationship between the emergence of various regimes, the aggregate endowments of the economy, and the initial distribution of assets. We limit ourselves to one remark. It can be shown that for a *given* inequality of asset distribution, the economy will display the characteristics of Regime 1 for 'intermediate' asset endowments, those of Regime 2 for 'low' asset endowments and full employment for 'high' endowments.[12] This should help to place the various regimes in perspective.

### *3.4. All equilibria are Pareto-optimal*

The equilibrium notion that we have introduced in section 3.1 and

[12]For a fixed asset endowment, the relationship between inequality and the various regimes is somewhat more complex, and we omit a detailed discussion.

discussed in section 3.2 does *not* coincide with that of a Walrasian equilibrium. This point was explicitly noted in our discussion of the first regime above. In the language of general equilibrium theory, our equilibrium may be viewed as a 'compensated equilibrium' [see, e.g. Arrow and Hahn (1971) for a precise definition]. It is well known that, in general, a compensated equilibrium may fail to be Pareto-optimal.

It is of some interest, therefore, that in our model the following result holds:

*Proposition 3.1. An equilibrium is Pareto-optimal*

For a proof of this proposition, see Appendix A.3. This strong result has clear implications. Even though an equilibrium may be characterized by involuntary unemployment, it is impossible to find another feasible allocation which makes everybody better off. Redistributive policies are therefore *necessary* to eradicate involuntary unemployment and undernutrition. Viewed from another angle, this result underscores the normative poverty of the Pareto-optimality concept in some realistic economic situations.

## 4. Inequality, demand and unemployment: The regime with assetless unemployed

In this section, we conduct an informal study of the demand composition problem in the context of Regime 1. Appendix A.4 contains formal proofs of the results discussed here.

We analyze two aspects of the demand composition problem. The first is the effect of a disequalizing change in asset distributions. The second relates to the accumulation of assets.

The following observations form the central feature of the arguments in this section.

Consider an equilibrium in Regime 1. Some assetless agents are employed and some are unemployed. Now consider a change in the economic parameters of the system (asset distribution, endowments) leading to a new equilibrium, and let us suppose that the new equilibrium is *also* in Regime 1. This supposition will be borne out, for instance, whenever the parametric change is small enough. What can be said about the two equilibrium price systems? Chiefly this: the *wage rate and the price of food will alter by exactly the same proportion.* The reason is simple: in Regime 1, the equilibrium wage rate in food units must be equal to the standard efficiency wage. Recalling (11) from section 3.1, we see that this wage *only* depends on the form of the conversion function, which is invariant across the two equilibria.

A corollary of this observation is that if the total land endowment is unchanged, the total supply of basic food will also be invariant across the two regimes. So will employment in the food sector.

We are now in a position to understand the implications for unemployment. Consider any change in the economic parameters that leads to an upward shift in the demand for food. Because the food supply is invariant, there are only two routes to the restoration of demand–supply equilibrium in the food market:

(A) the price of food (and meat) rises, suppressing the direct and derived demands for food, and/or

(B) employment falls, as a 'quantity rationing' device for lowering the demand for food.

Now observe: (A) can never account for the whole story! For as food prices rise, *the wage rate rises too in terms of clothing*. Employment in the clothing sector must, therefore, contract. We have already noted that food employment is unchanged. Therefore, involuntary unemployment increases and part (B) gets to play a role in the reduction of food demand. The market must react using *both* 'quantities' and 'prices'.

### *4.1. Disequalizing changes in the distribution of assets*

We will show in this section that a greater inequality in asset distribution leads to a parametric change precisely of the sort discussed above.

Consider an asset distribution $\langle t(n), k(n) \rangle$, and let $\pi^*$ denote an equilibrium price vector. Suppose, now, that there is a parametric shift of asset holdings in such a way that the new distribution of money wealth is Lorenz-inferior to the original distribution, evaluated at $\pi^*$. We will call such a shift *disequalizing*.

How does such a shift affect the demand for food, evaluated at the original equilibrium price/quantity configuration? Note, first, that the *direct* demand for food is unchanged [recall (3)]. The indirect demand for food is via the luxury product meat. Given our assumption that meat is a luxury, we know that the budget *share* of meat in consumer income *increases* with income. Consequently, a disequalizing shift must increase the total demand for meat, and so the total demand for food.

We may now attach to this starting point the rest of the argument above,[13] to conclude that involuntary unemployment rises. We therefore have:

[13]The formal analysis requires an additional assumption that is discussed explicitly in Appendix A.4. This assumption is related to the 'stability' of equilibrium, making the comparative-statics analysis meaningful.

*Proposition 4.1. In Regime 1, a disequalizing shift in the distribution of assets has the following effects:*

(*i*) *Food output is unchanged.*
(*ii*) *Clothing output declines.*
(*iii*) *Involuntary unemployment and undernutrition increases.*

This proposition provides a link between the inequality of wealth and the macroeconomic variables of the economic system. We should point out that the particular specification of our nutrition-based model is in no way necessary for these observations. We have already alerted the reader to a connection with human capital models of education. It may be of interest to re-read this proposition with appropriate changes in the interpretation of the various variables.

### *4.2. The accumulation of assets*

Consider, first, an increase in the aggregate endowment of capital. Of course, we wish this increase to be distributionally neutral with respect to the original distribution of capital, for the purpose of separating distribution effects from accumulation effects. Consider, therefore, an increase in the aggregate capital endowment that is distributed among existing capital owners in the same proportion as their initial holdings of capital.

It should be obvious that such an increase will raise the total demand for food (via increased meat demand), evaluated at the original equilibrium price. We are now in a position once again to tag on the basic argument at the beginning of this section. But there is one significant difference. Just as before, there are two possible effects: (A) a price rise, and (B) an employment decline, both of which act to lower the demand for food. But now our earlier argument that (B) *must* play a role does not necessarily work. The reason is that there are two opposing effects: while the wage rate (tagged to the price of food) rises in clothing units, tending to diminish employment in that industry, the increase in the capital stock raises the marginal product of labour, producing the opposite effect. The net effect will obviously depend on the significance of the food price rise, relative to the augmentation of capital stock.

It turns out that a pair of plausible assumptions, one on the clothing production function, and the other on the utility function *guarantee* that the 'price-rise effect' will outweigh the 'capital augmentation effect', causing employment in the clothing sector to decline! These assumptions are *not* 'stability type' assumptions but restrictions on the model itself, so let us pause for a moment to consider them:

*A.1.* $[C_k(K,e)K]/[C(K,e)]$ is a non-decreasing function of $K$ for each $e>0$.

*A.2.* At the original equilibrium, if a viable consumer's residual income is fixed in meat units, and the relative price of clothing falls, then meat consumption does not fall.

Assumption A.1 is technical. It is satisfied, for example, whenever the production function is Cobb–Douglas. The second assumption is one on the original equilibrium of the system, dealing with cross-price elasticities of demand.

These assumptions are sufficient (not necessary) to ensure that the market must respond to an augmentation of the capital stock by lowering aggregate employment. For details, see Appendix A.4. We therefore have a striking result:

*Proposition 4.2. Assume A.1 and A.2.*[14] *Then in Regime 1, a proportional accumulation of capital cannot increase employment.*

A corollary of this finding is that the capital-intensity of production increases in the clothing sector. Capital deepening is also an outcome of a disequalizing shift in asset distribution, as the reader will immediately see from Proposition 4.1.

The story is markedly different, however, in the case of an augmentation of the *land* asset. Such an augmentation has a direct impact on the supply of food and barring pathological situations, will invariably *lower* involuntary unemployment. We therefore observe an interesting dissimilarity in the effects of asset growth of the two kinds. Productive assets that are involved in the creation of basics expand employment as they grow. This is hardly paradoxical. What is of more interest, however, is the fact that productive assets which do not expand basic production, may *contract* employment as they grow. It is hardly necessary to dwell on the possible policy implications.

## 5. The regime with unemployment of asset owners: Some remarks

In Appendix A.5 of this paper, we formally discuss Regime 2 for the interested reader. Here, we limit ourselves to a few remarks on this regime.

The most significant methodological point to be noted in this context is that in general, a parametric change does *not* leave the wage unchanged in food units. Our method of analysis in the previous section rested on this invariance. With the invariance now missing, we consider only a special sort of Regime 2 equilibrium. This is described in Appendix A.5.

The question is: are there some additional features of this regime that *cannot* be observed in Regime 1? The answer is yes. While it is still true that capital accumulation has unambiguously negative effects on employment, it

[14]Here, too, we use an additional stability assumption. See Appendix A.4.

turns out that *asset redistributions have an ambiguous effect on employment. This ambiguity can be removed, however, by studying the employment status of the agents between whom the transfers are being made.*

Consider, for example, a disequalizing asset transfer from an unemployed asset owner to some employed asset owner. This transfer *reduces* the market demand for food at the old equilibrium price. The reason is simple. The unemployed asset owner spent *all* his asset income on food. The redistributed asset income, however, is *not* fully spent on food. One can now work through a reversal of the argument in section 4 to conclude that *this disequalizing transfer from unemployed to employed increases equilibrium employment.*

On the other hand, a disequalizing transfer between two *employed* asset owners must increase the (derived) demand for basics. The old argument then holds, and we may conclude that *a disequalizing transfer from employed to employed must lower employment.*

We note, too, that in Regime 1, only the second kind of transfer is possible, and this explains the unambiguity of our findings in that regime.

## Appendix

### *A.1. Specification of the demand system*

Define $R(\pi, n) \equiv rt(n) + \rho k(n)$ to be the non-labour income of $n$ at prices $\pi$. There are three cases to consider. First, consider the non-viable agent. His demand is

$$f_n = \frac{1}{p} R(\pi, n). \tag{A.1}$$

Second, consider the viable, employed agent. We recall from (3) that

$$f_n = f(p, v). \tag{A.2}$$

Define $Y(p, v) \equiv v\lambda(f(p, v)) - pf(p, v)$, and let $I(\pi, n) \equiv Y(p, v) + rt(n) + \rho k(n)$. This is $n$'s best residual income. Agent $n$ now solves

$$\max_{c, m \geqq 0 : c + qm \leqq I(\pi, n)} u(c, m). \tag{A.3}$$

Writing the demand functions as $d_c(\cdot)$ and $d_m(\cdot)$ for clothing and meat respectively, we obtain

$$c_n = d_c(q, I(\pi, n)), \tag{A.4}$$

$$m_n = d_m(q, I(\pi, n)), \tag{A.5}$$

Finally, define $I^{u}(\pi, n) \equiv \max\{0, R(\pi, n) - p\hat{f}\}$ in the case of the viable unemployed agent. His demands are

$$f_n = \min\left\{\hat{f}, \frac{1}{p} R(\pi, n)\right\}, \tag{A.6}$$

$$m_n = d_m(q, I^{u}(\pi, n)), \tag{A.7}$$

$$c_n = d_c(q, I^{u}(\pi, n)), \tag{A.8}$$

*A.2. Commodity market equilibrium*

We fill in the formal details on the definition of equilibrium. The equilibrium condition (10) in the main text implies that unemployed agents only consume whatever food they can buy with their rental income, and do not consume $m$ or $c$.[15] This observation simplifies (A.6)–(A.8), and coupling this with the simple supply function for meat, we may write the total demand supply equality for food as

$$F(T, e_f^*) = f(p^*, v^*)\mu(G^*) + \omega^{-1} \int_{G^*} d_m(q^*, I(\pi^*, n))\, \mathrm{d}\mu(n)$$

$$+ \int_{\sim G^*} R(\pi^*, n) \frac{1}{p^*} \mathrm{d}\mu(n), \tag{A.9}$$

where $\sim G^*$ denotes the complement of $G^*$ in $[0, 1]$, and $\mu$ is Lebesgue measure.

Finally, the demand-supply equation for clothing reads

$$C(K, e_c^*) = \int_{G^*} d_c(q^*, I(\pi^*, n))\, \mathrm{d}\mu(n). \tag{A.10}$$

[15] If this were not true for some $n \notin G^*$, $n$ could remain viable at *some* price system $\pi = (p^*, q^*, r^*, v, \rho^*)$ for some $v < v^*$.

### A.3. Proof of Proposition 3.1

It will be convenient to embed our model into a standard Walrasian setup, where its equilibria can be clearly seen as a particular type of compensated equilibrium.[16] Define

$$\Omega \equiv \{(F, C, M, -E, -K, -T) \in \mathscr{R}^6 \mid C \leqq C(K, e_c), F + \omega^{-1} M \leqq F(T, e_f),\ e_c + e_f = E\}. \tag{A.11}$$

Define, for each $n$,

$$\alpha(n) \equiv (0, 0, 0, 0, k(n), t(n)) \in \mathscr{R}^6_+, \tag{A.12}$$

and let

$$\Psi \equiv \{(f, c, m, -e, 0, 0) \in \mathscr{R}^6_+ \mid e = \lambda(f)\}. \tag{A.13}$$

Each agent $n$ faces the budget constraint $\{z \in \Psi \mid \pi z \leqq \pi \alpha(n)\}$ for each price vector $\pi$. Clearly, our competitive equilibrium is characterized by:

(i) $z^*(n) \in \Psi$ for all $n$, and $z(n) \in \Psi$, with $z(n)$ at least as good as $z^*(n)$ [for agent $n$] implies $\pi^* z(n) \geqq \pi^* z^*(n)$.
(ii) $\pi^* y^* \geqq \pi^* y$ for all $y \in \Omega$, with $y^* \in \Omega$.
(iii) $\int z^*(n) \cdot \mathrm{d}\mu(n) = \int \alpha(n) \cdot \mathrm{d}\mu(n) + y^*$.

Now we make an additional remark regarding (i):

*Claim.* Suppose $z(n) \in \Psi$, and $z(n)$ is strictly preferred by $n$ to $z^*(n)$. Suppose, moreover, that $e(n) \leqq e^*(n)$, where $e$ (resp. $e^*$) is the appropriate component of $z$ (*resp.* $z^*$). Then $\pi^* z^*(n) < \pi^* z(n)$.

The reader can easily verify this claim by noting that the *only* way in which an agent can be not maximizing his utility in our competitive equilibrium is if he is denied access to the labour market.

Now we can complete the proof of Proposition 3.1. Suppose, on the contrary, that there is another feasible allocation $(z(n), y)$, satisfying condition (iii) above, with $z(n) \in \Psi$ for a.e. $n$, such that $z(n)$ is at least as good (for $n$) as $z^*(n)$, a.e. $n$, and $z(n)$ is strictly preferred by $n$ to $z^*(n)$, for $n$ in some set of positive measure. By condition (i),

$$\pi^* z(n) \geqq \pi^* \cdot z^*(n) \quad \text{for} \quad \text{a.e. } n \tag{A.14}$$

[16] Conversations with Peter Hammond and Peter Streufert were very helpful in constructing the main idea of this proof.

First consider the case where (A.14) holds with equality for a.e. $n$. Look at $n$ s.t. $z(n)$ is indifferent to $z^*(n)$. For such $n$, it must be the case that $e(n) \geqq e^*(n)$. To prove this, note that either $e^*(n) = 0$, in which case the claim is obviously true, or $e^*(n) > 0$. In the latter case, $e^*(n) = \lambda(f(p^*, v^*))$. So if $e(n) < e^*(n)$, there would exist $z'(n) \in \Psi$ s.t. $\pi^* \cdot z'(n) = \pi^* \cdot \alpha(n) = \pi^* \cdot z^*(n)$, such that $z'(n)$ is strictly preferred to $z(n)$, *and* such that $e'(n) \leqq e^*(n)$. But this contradicts the claim above.

For $n$ such that $z(n)$ is strictly preferred to $z^*(n)$, it follows directly from the claim that $e^*(n) < e(n)$. So, in the new allocation,

$$E \equiv \int e(n)\, \mathrm{d}\mu(n) > \int e^*(n)\, \mathrm{d}\mu(n) \equiv E^*. \tag{A.15}$$

Also, using (iii) and the fact that we are in the case where (A.14) holds with equality for a.e. $n$, we have

$$\pi^* y = \pi^* y^*. \tag{A.16}$$

But using (A.15) and the fact that $F(\cdot,\cdot)$ and $C(\cdot,\cdot)$ are strictly concave in $e_f$ and $e_c$ respectively, it follows that there exists $y' \in \Omega$ such that

$$\pi^* y' > \pi^* y^* \tag{A.17}$$

and this contradicts part (ii) of the characteristics of equilibrium.

Finally, if (A.14) holds with strict inequality for a positive measure of agents, the reader can use standard arguments [e.g. Debreu (1959)] to arrive at a contradiction.

### *A.4. Propositions 4.1 and 4.2*

For the proofs of Propositions 4.1 and 4.2 we employ the following *stability assumption*:

*Assumption S.* Fix a competitive equilibrium $(\pi^*, G^*)$. Consider a parametric change in the parameters of the model, such that, *evaluated at* $(\pi^*, G^*)$, the total demand for food exceeds the supply of food, while the opposite is true for the clothing sector. Then the new equilibrium price of food exceeds the old.

*Discussion of the stability assumption.* Assumption S rules out perverse general equilibrium feedbacks. We can show that Assumption S *is implied by* the following uniqueness assumption:

*Asumption U.* For each specification of the model, there is a *unique* competitive equilibrium.

We omit the proof that Assumption U implies Assumption S, but it is available on request.

Alternatively, Assumption S is implied by the following pair of direct assumptions on the parameters of the system:

*A.3.* For each $K>0$, $C_e(K,e)e$ is a non-decreasing function of $e$.

*A.4.* Consider a given competitive equilibrium with meat price $q^*$. If the consumer income is fixed at any level in clothing units and if $q^*$ falls to $q$, then clothing demand does not increase at the new price.

*Proof of Proposition 4.1.* The assumption in section 2.3.3 may be rewritten as: for each $q$, if $0<I_1<I_2$, then for some $\gamma(q)>0$,

$$0<\gamma(q)\leqq\frac{qd_m(q,I_1)}{I_1}<\frac{qd_m(q,I_2)}{I_2}. \tag{A.18}$$

Now consider a disequalizing shift in the distribution of assets. Denote by $(\pi^*,G^*)$ the initial equilibrium, and by $(\pi^{*\prime},G^{*\prime})$ the final equilibrium. Because both equilibria are in Regime 1, we see from (11) that $v^*/\rho^*=v^{*\prime}/\rho^{*\prime}$. The profit maximization condition (5) now shows that $e_f^*=e_f^{*\prime}$, which establishes (i) of the proposition.

Consider the income distribution yielded by the new asset distribution evaluated at the *old* equilibrium prices and employment positions. It is clear, using (29), that the condition of Assumption S is met, so $p^{*\prime}>p^*$. Consequently, by the above argument, $v^{*\prime}>v^*$. Now we may use S to obtain (ii) of the proposition.

Combining (i) and (ii), (iii) follows right away.

*Proof of Proposition 4.2.* We assume A.1, A.2 and Assumption S. Denote all new variables by primes, as before. Because Regime 1 prevails throughout, we have

$$\frac{v^{*\prime}}{p^{*\prime}}=\frac{v^*}{\rho^*},\quad f(v^{*\prime},p^{*\prime})=f(v^*,p^*),\quad e_f^*=e_f^{*\prime}\quad\text{and}\quad\frac{r^{*\prime}}{p^{*\prime}}=\frac{r^*}{p^*}.$$

So, as in Proposition 4.1, all employment changes are due to the clothing sector.

Consider the demand effects of the parametric change evaluated at $(\pi^*,G^*)$. Clearly, there is an excess demand for meat because the residual income for all viable agents increase. Let $K'$ denote the new aggregate stock of capital. In the clothing sector, the increase in clothing output evaluated at the *old* price–employment position is $C(K',e_c^*)-C(K,e_c^*)$, while the increase in the demand for clothing is bounded above by $[1-\gamma(q^*)]\rho^*(K'-K)$, where $\gamma(q^*)>0$ is given by (A.18).

It is clear, using the original equilibrium condition (6) and the fact that $\gamma(q^*)>0$, that if $K'-K$ is small enough, an excess supply of clothing results. Let us complete the proof in this case.

Clearly, the conditions of Assumption S are satisfied so we know that $p^{*\prime}>p^*$ (and so $q^{*\prime}>q^*$).

Suppose, on the contrary, that $e_c^{*\prime}>e_c^*$. We claim, first, that

$$\frac{\rho^{*\prime}K'}{v^{*\prime}}>\frac{\rho^*K}{v^*}. \tag{A.19}$$

To see this, note that because $e_c^{*\prime}>e_c^*$,

$$\frac{\rho^{*\prime}K'}{v^{*\prime}}=\frac{C_k(K',e_c^{*\prime})K'}{C_e(K',e_c^{*\prime})}>\frac{C_k(K',e_c^*)K'}{C_e(K',e_c^*)}\geqq\frac{C_k(K,e_c^*)K}{C_e(K,e_c^*)}=\frac{\rho^*K}{v^*},$$

where the weak inequality in the above chain can easily be deduced from A.1.

Given (A.19) and the assumption of a proportionate capital increase, it follows that for every $n$ with $k(n)>0$,

$$\frac{\rho^{*\prime}k'(n)}{v^{*\prime}}>\frac{\rho^*k(n)}{v^*}. \tag{A.20}$$

Define $I(\pi^*,n)$ [resp. $I'(\pi^{*\prime},n)$] to be the residual income of $n$ in the old (resp. new) equilibrium. Using (A.20) and the preliminary observations in the first paragraph of this proof, it follows that for every $n$ with $I(\pi^*,n)>0$,

$$\frac{I'(\pi^{*\prime},n)}{q^{*\prime}}\geqq\frac{I(\pi^*,n)}{q^*} \tag{A.21}$$

with strict inequality holding on a set of agents of positive measure. Using (A.21), A.2 and the fact that $q^{*\prime}>q^*$, we may conclude that the aggregate demand for meat in the economy is higher under the 'primed' equilibrium. Furthermore, because $e_f^{*\prime}+e_c^{*\prime}>e_f^*+e_c^*$ and $f(\pi^{*\prime},v^{*\prime})=f(\pi^*,v^*)$, the direct demand for food is also higher. Given that $F(T,e_f^{*\prime})=F(T,e_f^*)$, this contradicts the demand–supply equality for food in the new equilibrium. So $e_c^*\geqq e_c^{*\prime}$.

Finally, we argue that our result holds true for *all* proportional changes in capital stock, not just 'small' ones. For suppose this were not true for some $K^1$ and $K^2$. Then there *must* exist a $K\in[K^1,K^2)$ such that for *every* proportional increase of $K$ to $K'$, $e_c^* < e_c^{*\prime}$. Taking a small enough change, we have a contradiction by our previous argument.

### *A.5. Inequality and unemployment: Regime 2*

Along with the assetless, some asset owners are unemployed under Regime 2: their asset income, at the given price, is too low for them to participate in the working labour force. The picture one can draw of the consequences of various types of parametric variations is therefore more complex than under Regime 1. There, the demand aspect of the problem was at the core of our analysis. Here, the impact of price movements on the working status of the asset owners has to be taken into account. In view of this basic difficulty, our analysis will be restricted to equilibria such that all capital owners are always fully employed and a group of agents of positive measure has exactly the same assetholding as that of the just-employed or *marginal worker.* This group consists thus of small peasants owning the same amount of land. We will assume that the parametric variations under analysis are such that, in any resulting equilibrium, changes in employment affect the working status of only the marginal group. Let us define an *asset transfer* as the move from a given asset distribution to another one. An asset transfer will be said to be *disequalizing* (resp. *equalizing*) if the new distribution is Lorenz-inferior (resp. superior) relative to the old one, evaluated at the old equilibrium prices. Let $(\pi^*, G^*)$ be a given equilibrium. An asset transfer to $\{t'(\cdot), k'(\,,)\}$ is defined as *conservative* if:

(i) $r^* t'(i) \leqq r^* t(n^*)$,

(ii) $r^* t'(j) + \rho^* k'(j) \geqq r^* t(n^*)$,

for all $i \in \sim G^*$, $j \in G^*$, with $n^*$ being the marginal worker. A conservative asset transfer thus does not change the position in asset holdings of the agents between whom the transfer is being made, relative to that of the marginal worker under the equilibrium price system $\pi^*$. With this in mind, we can now turn to the following propositions:

*Proposition A.5.1. Under Assumption S, a conservative disequalizing asset transfer among* employed *agents decreases employment.*

*Proposition A.5.2. Under A.1, A.2 and Assumption S, a proportional increase in the aggregate capital stock does not increase employment.*

*Proposition A.5.3. Under Assumption S, a conservative equalizing asset transfer from the employed group of asset owners to the employed one increases unemployment.*

We omit proofs, which are essentially along the lines of Propositions 4.1 and 4.2.

Propositions A.5.1 and A.5.2 are simple extensions of the Regime 1 results to a particular class of Regime 2 equilibria. But Proposition A.5.1 taken together with Proposition A.5.3 yields a major difference. Equalizing asset transfers have an ambiguous effect on employment, *depending on the working status of the agents between whom the transfer is being made.* Proposition 5.1 is analogous to the unambiguous Proposition 4.1 of Regime 1. The more disequalizing the asset transfer, the larger the extent of unemployment. Here, the asset transfer occurs between employed agents. However, in the case of a conservative equalizing transfer from employed to unemployed (Proposition A.5.3), the situation is reversed. Such a transfer increases the total demand for food, because the unemployed agent spends the totality of his new asset income on food.

The situation is yet more complicated. An equalizing asset transfer between employed and unemployed that permits the formerly unemployed to participate in the labour market (i.e. a *non*-conservative transfer) has ambiguous effects. This will increase the supply of food in the new equilibrium. 'In the limit', a perfectly equalizing asset distribution *will* increase employment, if the economy is intrinsically productive enough to adequately feed all agents.

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