Distribution of Agricultural Surplus and Industrial Takeoff

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Abstract

This paper analyses how the distribution of agricultural product affects industrial takeoff and aggregate income through the demand side. We carry out an equilibrium analysis for different levels of wages proving that there is a strong non-linear relation between income and inequality which is considerably different from the inverted ∪-shaped *Kuznets Curve*. Unlike Murphy et al. (1989), assuming functional distribution of income, the increase in the share of workers' agricultural surplus can sustain industrialization without the necessity of the emergence of a middle class.

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1 Introduction

This paper analyses how the distribution of agricultural surplus affects industrial takeoff and aggregate income by shaping the composition of effective demand. Our contribution is based on the literature of structural change which investigates the link between inequality – in term of income – and industrialization taking into account the composition of demand. See for instance Murphy et al. (1989), Baland and Ray (1991), Eswaran and Kotwal (1993) and Matsuyama (2002).[1] The basic productive structure which is assumed in these contributions is that of the dual economy studied in Rosestein-Rodan (1943), Lewis (1954, 1967) and Fleming (1955) between the 1940s and 1960s. In particular, Murphy et al. (1989) proposed a model of early industrialization where the takeoff is sustained by domestic demand and the extent of industrialization is determined by the distribution of income. They studied the relationship between income distribution and the size of domestic demand assuming that i) individuals have hierarchical preferences, ii) industrial manufacture involves a fixed set up cost, so it needs a large enough market to reap scale economies, and iii) a fraction of the labour force receives, besides wages, a share of profits and rents. In particular, the distribution of shares affects the composition of demand which, in turn, affects the profitability of mass production. Their analysis focuses on proving the necessity of a "middle class as the source of the buying power for domestic manufactures".[2]

Murphy et al. (1989) model the distribution of profits and rents in such a way that an indistinguishable fraction of individuals has the same quota of both. This distributional assumption seems far from the historical contest of industrializing economies.[3] Countries about their industrial takeoff are characterized by a sharp functional division of income, it is not plausible to assume that workers get a share of agricultural rents and firms

[1]More recently, Zweimüller (2001) and Mani (2001) sought to consider explicitly the growth process by investigating how hierarchical demand influences technological progress.

[2]See Murphy et al. (1989, p.538).

[3]Take for instance the case of Colombia (Murphy et al., 1989, p.539-40).

profits. Furthermore, if the agricultural sector is the leading sector, it is interesting to investigate the relationship between the level of wages and aggregate income.

Following this argument, we maintain the first two basic assumptions of Murphy et al. (1989) but we assume a functional division of property rights among social classes – land is owned by landowners, each firm is owned by a capitalist – which results in a functional division of income – workers earn only wages, rents go to landowners, profits go to capitalists. This distributional change allows us to investigate how an increase in the share of agricultural production in favor of workers changes the composition of manufactures demand. This change is crucial in order to provide the demand necessary for the industrial takeoff. Our model shows that under functional distribution, the general result provided by Murphy et al. (1989) – namely the necessity of the middle class for industrialization – does not hold. If agriculture is enough productive an increase in the level of wages can sustain industrialization without the emergence of the middle class.

The economy we describe is composed of two sectors: agriculture, which provides food, and manufacturing which is constituted by a continuum of markets each providing a different commodity. Consumption is assumed to be incremental in the sense that the higher the income, the greater the variety of goods consumed. This is consistent with the hypothesis of hierarchical preferences. Moreover, individuals have the same tastes, which implies that they demand goods according to the same schedule of priorities.

Industrialization is conceived as the substitution of a traditional technology – showing constant returns to scale – with an industrial one – showing increasing returns to scale. In each manufacturing market, artisans using traditional technologies compete with each other driving profits to zero. A single artisan per market has access to the industrial technology. If she faces enough demand she can become an entrepreneur and monopolize the market making positive profits.

Following a long tradition in the literature of economic development, we assume that agricultural workers get as wage a share of total output. This share can be higher or lower depending on the institutions of the society, and more generally on the history of the country. This assumption allow us to easily study the increase in wage as an increase on the share of workers' agricultural product. Despite the fact that the increase in wages increases the price of manufactures, we found that the increase of wage can sustain industrial takeoff.

The second important message of this paper is that we obtain an interesting relation between income and inequality. In particular under reasonable assumption as long as inequality decreases the income first increases, then decreases and after a certain boundary start rising again. This relation is different from the classical Kuznets Curve. More precisely, we add a positive relation between income and reduction of inequality for low level of wages, that is, for high level of inequality.

The rest of the paper is organized as follows: section II presents the basic model; section III discusses the result obtained; section IV builds the relationship between income and inequality; section V contains concluding remarks.

2 The Model

2.1 Commodities and Consumption Patterns

There is a single homogeneous divisible agricultural good. For simplicity we label it *food* and use it as numeraire. Moreover, there is a continuum of manufactured goods represented by the open interval $[0, \infty) \in \Re$. Each good is denoted by its distance q from the origin. The consumption pattern – or tastes, if one prefers – is assumed to be the same for each individual. There exists a subsistence level of food consumption $\bar{\omega}$. Moreover let us denote by z the minimum amount of food required before agents start consuming manufactures – with $z > \bar{\omega}$. After that, any unit of income is spent to buy the manufactured goods following their order in the interval.

This assumption is intended to be a simple way of introducing a common ranking of necessities: as long as income grows, people first need to buy what is necessary to survive, then they buy food until the saturation level z, then basic manufactures and durables which allow better life standards and, only after that do they buy luxuries. For simplicity, we assume that only one unit is bought of any manufactured good. In other terms, any individual with income $\omega \geq z$ uses her first z-units of income to purchase food and $(\omega - z)$ to purchase the manufactured goods. Any individual with $\omega < \bar{\omega}$ starves.

It is worth pointing out the intuitive consequences of our assumptions. First, individuals are almost identical in terms of their consumption decisions and they only differ in income. Thus, a landowner and her servants would consume the same if given the same income. Second, any increase of income above z results in an increase of consumption variety. In particular, richer people buy the same bundle of poorer people plus some other commodities.

2.2 The Agricultural Sector

In order to produce food it is necessary to use land and labour. We abstract from land and assume it is always fully utilized in production. For the sake of simplicity, we also assume all workers have the same skills – labour is homogenous.

Technology and Incomes. Given the amount of land utilized, labour has decreasing marginal productivity. Total production is determined by the function $F(L_F)$ where L_F is the number of workers employed in agriculture. It is assumed that $F' > 0$, $F'' < 0$.

Agricultural production in shared between wages and rents in accordance with the parameter λ. This implies that

$$w_F \equiv W_F/L_F = \lambda \frac{F(L_F)}{L_F}, \tag{1}$$

and

$$R = (1 - \lambda)F(L_F), \quad (2)$$

where W_F is the total amount of wage in agriculture, w_F the per capita wage, R the total amount of rents. We assume the level of λ defined by institutional specificities and more generally by the history of the country. Although this formalization is not always consistent with a competitive agricultural market, note that if the production function shows constant elasticity of substitution (as in the Cobb-Douglas case) then there exists a level of λ which does not depend on L_F such that $w = F'(L_F)$. The advantage of this formalization is that it is possible to investigate the aggregate result of changes in the distribution of agricultural product between classes through variations in λ.

Land Ownership. Differently from Murphy et al. (1989), we assume property rights of the land stock to be equally distributed among M landowners. We also assume that the income of each landowner (i.e. the per capita rent r) is equal to R/M and, hence, is negatively related to their number.[4] The idea is that, on average, the greater the number of landowners, the smaller is the area of land they possess and, therefore, the lower the rent they earn. Although a non-uniform distribution of land property rights is the norm, our simplification works well as long as the average concentration is the relevant feature. In this sense, M should be interpreted as a rough index of land property concentration. Moreover, since landowners do not work their land we must assume that $r \geq w$, that is $\lambda \leq \frac{L_F}{L_F+M}$.

2.3 The Manufacturing Sector

We consider a continuum of markets where each is small with respect to the entire economy. The number of workers employed in the manufacturing sector as a whole is denoted by L_M while the ruling wage is w_M.

[4]Murphy et al. (1989) do not consider the existence of landowners as individuals: in their model, agricultural production – like industrial production – is organized by firms which divide their profits among a certain number of shareholders.

Technology and Markets. Each commodity q is produced with the same cost structure. Two technologies are available. The first, labeled *traditional technology* or TT, requires α units of labour in order to produce a unit of output. This represents the case in which commodities are produced by artisans who, at the same time, organize production and work like other wage-paid laborers. For this reason, the number of workers in TT markets also includes artisans. The second, labeled *industrial technology* or IT, requires k units of labour to start up plus β units of labour per unit of output produced, with $0 < \beta < \alpha$. This represents the case where a former artisan becomes an entrepreneur exploiting the benefits of mass production.

Furthermore, we assume $(k + 1) > (\alpha - \beta)$ which means that the amount $(\alpha - \beta)$ of labour saved producing one unit of output using IT is less than the fixed amount k needed to introduce the IT plus the unit of labour provided by the artisan. Clearly, this is the only interesting case because if $(k + 1) \leq (\alpha - \beta)$ IT never requires more units of labour with respect to TT and, hence, it is always preferred by artisans. Lastly, we denote by E the number of entrepreneurs.

Notice that TT shows constant returns to scale while IT shows increasing returns. The difference between these two technologies represents the economic advantage of industrialization.

Competition and Income. A group of competing artisans is assumed to operate in each market q of the economy. Given a wage w_M, any amount of commodities can be produced and sold at the unit price αw_M. No profits are earned by artisans. Besides, in each market q there exists one and only one artisan who knows IT. If she decides to be an entrepreneur she can become a monopolist by slightly undercutting the price αw_M. In this case nobody buys the good produced with TT and profits of market q are

$$\pi(q) = [(\alpha - \beta)D_q - k]w_M \tag{3}$$

where D_q is the demand faced by market q.

2.4 Population and Labour Market.

Agricultural employment determines the ruling wage w_F. We assume perfect mobility of labour among sectors and markets so that $w_F = w_M = w$.

The active population is denoted by L and each worker either supplies inelastically one unit of labour or becomes an entrepreneur. The total supply of labour is hence equal to $L - E$. Finally, the population is assumed to be fixed and equal to $N = L + M$ where $L = L_F + L_M + E$.

3 Analysis

3.1 Industrialization.

As we pointed out above, only one artisan in each market knows the industrial technology (IT). She finds convenient to introduce the IT if and only if the profit $\pi(q)$ is not lower than the ruling wage w. Hence, from equation 3, the condition in market q for the industrial takeoff is

$$D_q \geq \rho, \tag{4}$$

where $\rho \equiv (k+1)/(\alpha - \beta)$.

Consider the economy we have described so far and assume that the agricultural sector is already in equilibrium. Denote with Ω_m the total expenditure in manufactures and with ω_i the income of individual i. Since every consumer who has already bought z units of food spends her remaining income to get a unit of each manufacture in the specified order, the demand D_q faced by a generic market q is determined by the number of individuals who earn enough income to buy at least commodity q – namely $(\omega_i - z)/\alpha w > q$.

Since IT is introduced only when demand goes over a certain profitability threshold, if the number of landowners is low, namely $M < \rho$, then industrialization is prevented. Note that by also increasing the income of landowners the demand in each market remains constant, and it would be not sufficient to push the introduction of IT.[5] Therefore in this case the demand for manufactures of workers is necessary for the industrial takeoff.

When workers start demanding manufacturing the threshold for industrialization is exceeded, some markets industrialize and entrepreneurs make positive profits. This starts a multiplicative process of demand sustained by entrepreneur earnings. Such a process can go on for several steps – profits, new demand, new profits – but in each step the amount of new profits decreases because the new demand partially goes to cover production costs which are constituted by wages spent in food. In particular, the process ends when new generated profits fail to industrialize new markets or to generate extra demand for markets already industrialized.

3.2 Agricultural Equilibrium.

In order to clarify the impact of change of agricultural product composition on the income of the economy, we focus on the case in which agriculture is enough productive to allow always manufactures consumption. Taking into account that landowners are richer than workers, this additional assumption means that $F(L_F) > z(L_F + M)$.

The agricultural market is in equilibrium when the following expression holds

$$F(L_F) = min\{w, z\}L + zM, \tag{5}$$

where the LHS the RHS of equation (5) are respectively the supply and the demand of food. When $w \geq z$ the demand is fixed and L_F does not change. When instead $w < z$, an increase in λ implies and increase of the demand of food and agricultural employment. Then, in equilibrium there will be a shift of workers from manufacturing to agricultural sector. The following analysis aim at investigating the aggregate level of income driven by this structural change. In order to evaluate the variation in L_F given

[5] The impact of landownership concentration on industrialization is analyzed in a companion paper (Bilancini and D'Alessandro, 2005).

by changes in λ at equilibrium, let us define

$$\phi(L_F, \lambda) = F(L_F) - wL - zM, \tag{6}$$

the implicit function of L_F and λ. Given equation (5), at equilibrium $\phi(L_F, \lambda) = 0$. By applying the implicit differentiation theorem we obtain

$$\frac{dL_F}{d\lambda} = \frac{FL_FL}{F'L_F^2 + \lambda L(F - F'L_F)}, \tag{7}$$

where $F \equiv F(L_F)$ in order to simplify the notation. Since the food production function is concave, it is trivial to prove that, as expected, $dL_F/d\lambda > 0$. Given this derivative, the variation of wage at equilibrium given by an increase of λ is

$$\begin{aligned} \frac{dw}{d\lambda} &= \frac{L}{L_F} - \lambda \frac{F - F'L_F}{L_F^2} \frac{dL_F}{d\lambda}, \\ &= \frac{L}{L_F} \left\{ 1 - \lambda \frac{F(F - F'L_F)}{F'L_F^2 + \lambda L(F - F'L_F)} \right\}. \end{aligned} \tag{8}$$

As expected, it holds $dw/d\lambda > 0$.

The shift of workers from manufacture to agriculture modifies the composition of income, and its aggregate value. Whether this change increases or reduces the level of income depends on the difference between the productivity of agriculture and manufacture. Note that while the agricultural sector has decreasing productivity the manufacturing sector show constant returns of scale. The income of the economy without industrialization is

$$Y = R + wL = (1 - \lambda)F + \lambda L \frac{F}{L_F}. \tag{9}$$

Hence,

$$\begin{aligned} \frac{dY}{d\lambda} &= -F + (1 - \lambda)F' \frac{dL_F}{d\lambda} + \frac{FL}{L_F} - \lambda L \frac{F - F'L_F}{L_F^2} \frac{dL_F}{d\lambda}, \\ &= \frac{FF'L_F^2[L - L_F + (1 - \lambda)L] - \lambda FL_FL(F - F'L_F)}{L_F[F'L_F^2 + \lambda L(F - F'L_F)]}. \end{aligned} \tag{10}$$

Therefore,

$$\frac{dY}{d\lambda} \geq 0 \Longleftrightarrow \lambda \leq \frac{F' L_F}{LF}(2L - L_F) \Longleftrightarrow w \leq F' + \frac{L_M}{L}F'. \tag{11}$$

The last inequality of 11 is particularly interesting. As long as λ increases, aggregate income increases if and only if the level of wage at equilibrium is lower than the marginal productivity of agricultural sector (the level of wage under perfect competition) plus the quota of workers employed in the manufacturing sector payed at the productivity of agriculture. However this inequality depends on the level of λ. An increase in λ increases the LHS of the last inequality of 11 increase, while decreases its RHS since the increase in L_F reduces F' and L_M. This result holds when the whole income of workers is spent in food, namely $w < z$ since otherwise an increase in wage does not change the aggregate demand of food.

The technology of agricultural sector plays the key role: If the labour productivity is really low an increase of wage can always decrease the aggregate income of the economy until the workers do not start consuming manufacturing. From the other hand if the agricultural productivity is high, the income of the economy can always increase. However, the more reasonable case is that the relation between wage and income shows an inverted $\cup$-shape until the saturation level in the consumption of food is not reached. This results is surprising since it describes a relation between income and inequality opposite to the renowned *Kuznets Curve*.

3.3 Profits

When λ is high enough to imply $w \geq z$ the demand of food is fixed. Workers spend $w - z$ in manufactures consuming commodities in $[0, Q_L]$, where $Q_L = (w - z)/\alpha w$. Hence, markets in $[0, Q_L]$ face a demand equal to N. If $N > \rho$, these markets introduce the IT. The additional income of entrepreneurs, $(\pi_q - w)$, is spent in markets beyond Q_L until market Q_π. Given equation (3), $Q_\pi = \{[(\alpha - \beta)N - k]w - z\}/\alpha w$. Hence, markets in $[Q_\pi - Q_L]$ face the entrepreneurs' demand, i.e. Q_L. Assuming that landowners are few, namely $M < \rho - 1/\alpha$, no other market introduces the IT. Indeed, it is technically impossible that $Q_L > \rho$ since the profits created by workers demand are not able to induce new markets to industrialize. However, it is possible that new market industrialize if the demand of landowners cover a part of start-up costs. If $M < \rho - 1/\alpha$, then $M + Q_L < \rho$.

Under these conditions, the aggregate income is

$$Y = F(L_F) + D_M \alpha w, \tag{12}$$

where the manufacturing aggregate demand $D_M \equiv [Q_L N + (Q_\pi - Q_L) Q_L + (Q_R - Q_L) M]$. Simplifying equation (12), we get

$$Y = F(L_F) + w L_M + \Pi, \tag{13}$$

where the total profits are $\Pi \equiv \frac{(\alpha-\beta)}{\alpha}(N-\rho)(w-z)$. From equation (13), it is trivial to prove that any increase in λ increases the income of the economy. Note that abstracting from profits, the total income would increase since L_F is fixed. However, this increase in income is only in value terms, the units of goods produced do not change. On the contrary, the advantage of industrial technology increases also the units of manufacturing goods produced. Equation (13) can be rewritten in order to depend only from the parameters of the model. In this case we have

$$Y = F(L_F) - \frac{z}{\alpha}[(\alpha-\beta)(N-\rho)-1] + \lambda \frac{F(L_F)}{\alpha L_F}[\alpha(N-M-L_F) + (\alpha-\beta)(N-\rho)-1]. \tag{14}$$

4 Income and Inequality

The analysis done so far highlights the impact of the distribution of agricultural product between landowners and workers on the industrial takeoff. In the general case we have that as long as λ increases the income first increases then it decreases and when the workers start consuming manufacturing good it increases again. Figure 4 shows this non-monotonic relation.

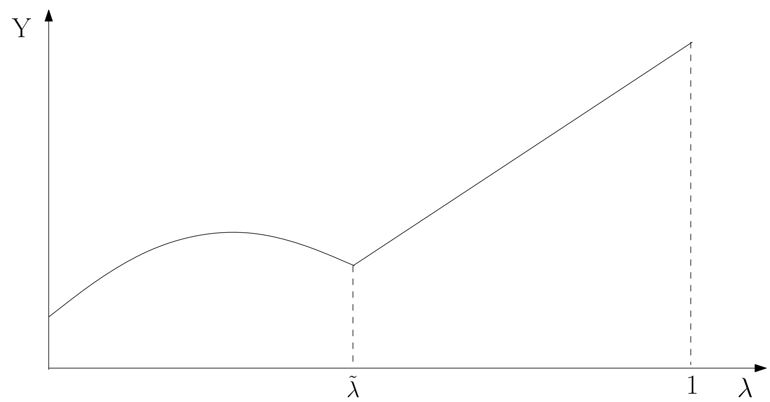

Figure 1: Income and Distribution of Agricultural Product.

In Figure 4, $\tilde{\lambda}$ represents the value of λ which makes the wages equal to z, that is $\tilde{\lambda} = z\frac{L_E}{F(L_E)}$. After that point, the workers' manufactures demand is sufficient to enhance income, thanks to the increasing returns to scale of industrial production. Figure 4 captures an additional effect. As long as λ increases the inequality of the economy is reducing. This obviously holds when workers do not consume manufactures but even when there is the new class of entrepreneurs which can increase their income above the one of landowners. Two features of the model explain this result. First, the increase of income is driven by the increase of wages, that is the income of the poorer class of the economy. Secondly, the numerosity of the classes is in favor of workers. This means that even if the entrepreneurs are very rich, their number is low compared to the one of workers, and therefore the inequality of the economy is always decreasing when λ and then wages increase.

5 Concluding Remarks

In this paper we analyzed how the distribution of agricultural surplus affects income and industrialization through the demand side. In order to do so, we developed a modified version of the model of Murphy et al. (1989). The main novelty of our model is that we assume a functional distribution of income. The motivation for this choice is two-fold:

we find that it is not only a better representation of an early industrializing country but it also allows us to investigate in greater detail the impact of agricultural surplus distribution on income and industrialization.

Differently from the general results on income distribution found in Murphy et al. (1989), we showed that industrialization can be sustained without the emergence of a middle class. The increase of wage, despite the consequent increase in prices of manufacturing goods, leads to industrial takeoff when their income is enough to consume manufactures. After that threshold, we found a direct relationship between income and level of wages.

More importantly, since the increase of wages always reduces the inequality in the society, we get a relation between inequality and income. This relation is more elaborated than the Kuznets Curve, since when wages and income are very low, the reduction of inequality has a positive effect on income.

Few remarks on the nature of these results are worth making. In our analysis there is no dynamics and all results come from a comparative statics exercise. Therefore, this study does not offer any reliable prediction about the impact of *changes* in agricultural surplus distribution. Nevertheless, the comparative statics we carried out tells us something important. If a country is on the threshold of industrial takeoff we expect that, *ceteris paribus*, countries with a higher level of wages can perform better, and can sustain a larger industrial sector.

Further research should provide a detailed analysis of the role of agricultural productivity, taking into account the issue of unemployment.

References

J.-M. Baland and D. Ray. "Why Does Asset Inequality Affect Unemployment?". *Journal of Development Economics*, 35:69–92, 1991.

E. Bilancini and S. D'Alessandro. "Functional Distribution, Land Ownership and Industrial Takeoff". *Quaderni del Dipartimento di Economia Politica*, 467, 2005.

M. Eswaran and A. Kotwal. "A Theory of Real Wage Growth in LDCs". *Journal of Development Economics*, 42:243–269, 1993.

J. M. Fleming. "External Economies and the Doctrine of Balanced Growth". *Economic Journal*, 65: 241–256, 1955.

W. A. Lewis. "Economic Development with Unlimited Supplies of Labour". *The Manchester School*, 22:139–191, 1954.

W. A. Lewis. "Unemployement in Developing Countries". *World Today*, 23:13–22, 1967.

A. Mani. "Income Distribution and the Demand Constraint". *Journal of Economic Growth*, 6:107–133, 2001.

K. Matsuyama. "The Rise of Mass Consumption Societies". *Journal of Political Economy*, 110(5): 1035–1070, 2002.

K. M. Murphy, A. Shleifer, and R. W. Vishny. "Income Distribution, Market Size, and Industrialization". *Quarterly Journal of Economics*, 104:537–564, 1989.

P. N. Rosestein-Rodan. "Problems of Industrialization of Eastern and South-eastern Europe". *Economics Journal*, 53:202–211, 1943.

J. Zweimüller. "Schumperterian Entrepreneurs Meet Engel's Law: The Impact of Inequality on Innovation-Driven Growth". *Journal of Economic Growth*, 6:107–133, 2001.