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Abstract

This paper analyzes a simple two-sector model of structural change to illuminate the factor bias of technical change in agriculture in the process of structural transformation. Both land- and labor-augmenting technical changes are effective when households enjoy food level consumption close to the level of subsistence. However, as the economy moves away from the state of subsistence, the absolute and relative effectiveness of land- and labor-augmenting technical changes depends on the elasticity of substitution between land and labor. Calibration of the model for today's developing countries suggest that all countries can benefit from labor improvements but only some regions of the world will benefit from an emphasis on land improvements.

JEL classification: O11, O13, O14, O33
Keywords: structural transformation, agricultural productivity, technical change

1 Introduction

As emphasized recently by Rodrik et alii (2015), one the two broad development challenges of today's developing countries is the "structural transformation" challenge, that is, a quick and continuous flow of production factors from traditional to modern economic activities. The persistence of large traditional sectors throughout much of the developing world has raised interest in the theoretical underpinnings of this transformation, with an emphasis on agricultural development.

Various statements and insights about structural change have already been made. Matsuyama (1992) and Gollin, Parente & Rodgerson (2002) shed light on the central role of agricultural productivity in causing industrialization and long-run economic growth. Matsuyama however states that a high agricultural productivity might be damaging in the context of an open economy and learning-by-doing effects in the manufacturing sector. Laitner (2000) shows that features of structural change produce an endogenous increase in the savings rate and a relative reallocation of wealth in reproducible capital. Kongsamut, Rebelo & Xie (2001) prove that a balanced growth path is compatible with the main features of structural change and among them, the rise of the employment and output share of services. Ngai & Pissarides relate the evolution of sectoral employment with the difference between sectoral TFP growth rates

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and the substitution regime among consumption goods. In the long run, they show that the working population is entirely absorbed by the sector with the lowest TFP growth and the sector producing investment goods. Irz and Roe (2005) use a numerical procedure to state that land resource per capita affects positively industrialization and improves the rate of capital accumulation. Finally Vollrath (2009), in the context of an endogenous fertility model, stresses on a low income share of labor in agriculture as a determinant of income per capita and industrialization.

Following an insight first formalized by Matsuyama (1992) all these authors insist on growth of agricultural productivity for structural transformation to occur[1]. But the specific role of land- versus labor- augmenting technical change in this process is not clarified. Yet as shown by Hayami and Ruttan (1985) and Ruttan (1977), countries that went through successful agricultural development experienced directed technical change in favor of the relatively scarce factor (i.e. land in Japan and Taiwan, labor in the United States, Canada and Australia), an observation that raises the question of the type of technical change involved in structural transformation. More recently, however, Bustos, Caprettini and Ponticelli (2016) brought theoretical and empirical evidence on the effect of factor-biased technical change in open economies, showing that while labor-augmenting technical change can be expected to speed up industrialization, land-augmenting technical change has the opposite effect.

This paper elucidates the effect of labor- and land-augmenting technical change in agriculture on industrialization in the context of a closed economy. I show under fairly general circumstances that improvements in land productivity will trigger structural change if the elasticity of substitution between land and labor is *high* and/or if the economy is close enough to a state of subsistence. On the other hand, improvements in labor productivity will trigger structural change if the elasticity of substitution between land and labor is *low* and/or if the economy is close enough to a state of subsistence. Also, the relative effectiveness of land and labor improvements depends upon the elasticity of substitution. Once the theoretical statement has been made and its underlying intuitions unveiled, the next section is devoted to a calibration of the model, and I give hints as to which regions of the developing world might benefit the most from increased land productivity in the structural transformation of their economies. The last section concludes and gives directions for further research.

My model can be seen as a natural extension of Matsuyama's (1992) model in a closed economy, where the factor-bias of technical change has been taken into account. It is also strongly complementary to the work of Bustos, Caprettini and Ponticelli (2016), since their analysis focus on the case of an open economy. In the calibration section, I compute the elasticities of agricultural labor with respect to land- and labor-augmenting technical change directly from the model, and they are calibrated using just a few economic indicators, namely, the income share of land, proximity to subsistence, the elasticity of substitution, and the share of food spending. This calibration, relatively parsimonious in data and concepts, intends to be very close in spirit to growth accounting and the literature on income shares, as it requires mainly data from the national accounts.

[1] Vollrath's model put forward the agricultural income share of labor, not agricultural TFP, as a long-run determinant of industrialization. Nonetheless, it belongs to the technology parameters of agriculture and can be understood as a loose form of agricultural productivity.

2 Structural change and substitution possibilities in agriculture

2.1 The general case

In the simple framework of this study there are only two sectors of productions. The primary sector, agriculture (Y^A), uses augmented labor ($\hat{L^A} = A_L L^A$) and augmented land ($\hat{S} = A_S S$), where A_L and A_S stand for the productivity of respectively labor and land. I do not focus on land utilization through harvesting and simply assume that land enters the production function directly. A_L embodies technologies and inputs such as herbicides and agricultural machines, that extend the power of the labor force without affecting the amount of land used. A_S embodies technologies and inputs such as additional harvesting seasons, fertilizers and high-yielding crops that are akin to a land extension without affecting the labor force. In practice, new inputs or techniques may improve both components at the same time. For instance, a genetically engineered crop might be resistant to herbicides (and will therefore save on the labor used to weed) and might also take less time for maturing, enabling the farmer to set up an additional planting and harvesting cycle (which amounts to land extension). The agricultural sector is therefore to be seen the sector where most of the population would work initially. The secondary sector (Y^M) is identified with manufacturing and services and uses labor (L^M) as input and possibly other fixed inputs. Thus:

$$\begin{aligned}
Y^M &= M\,F(L^M), \\
Y^A &= A\,G(\hat{L^A}, \hat{S}), \\
\hat{L^A} &= A_L L^A, \quad \hat{S} = A_S S.
\end{aligned} \tag{1}$$

I complete the description of the technology by fairly general hypotheses on the production functions:

$$\begin{aligned}
&(i)\; F, G \text{ are of class } C^2 \\
&(ii)\; F' > 0, \quad F'' \leq 0 \\
&(iii)\; G_{\hat{L^A}} > 0, \quad G_{\hat{S}} > 0, \quad G_{\hat{L^A}^2} < 0 \\
&(iv)\; G \text{ has constant returns to scale.}
\end{aligned} \tag{2}$$

I assume the existence of a representative household taking prices as given. Its preferences are given by the following utilitarian framework:

$$U(C^A, C^M) = (C^A - \lambda)^{\nu^A} (C^M)^{\nu^M}, \qquad \nu^A + \nu^M = 1, \tag{3}$$

and the set of feasible consumption is such that $C^A \geq \lambda$, $C^M \geq 0$. The Stone-Geary argument embedded in (3) is one of the simplest way to take into account Engel's law and was first used in the context of structural change by Matsuyama (1992). In the context of a representative household, the minimum food level λ is by aggregation an average of the minimum food level of all households. Though Cobb-Douglas preferences are somewhat constraining, Appendix B shows that the main ideas conveyed by this paper can be extended without difficulty to a framework with CES preferences, with the cost of an added layer of subtleties.

The representative household owns the land and is endowed with a constant amount of labor set to one for simplicity. I normalize the price of the manufacturing good to one and denote the price of the agricultural good by p^A, the price of the rent on land by q and the real wage by w. Thus the budget constraint of the representative household is the following:

$$p^A C^A + C^M = w + qS + \pi, \tag{4}$$

where π denotes profit from both the agricultural and manufacturing sectors. To complete the description of this economy, market clearing needs to be clarified. I assume there is no capital accumulation and the economy lives in autarky. This yields:

$$\begin{aligned} 1 &= L^A + L^M, \\ C^M &= Y^M, \\ C^A &= Y^A. \end{aligned} \tag{5}$$

Having finished the description of the economy, I now study its market equilibrium in order to find the implication of a change in land or labor productivity on the distribution of employment across sectors. Interior solution of utility maximization for the representative household imply the following:

$$\frac{U_{C^A}}{U_{C^M}} = p^A. \tag{6}$$

Production decisions in agriculture and manufacturing are taken by profit-maximizing entities, acting as price-takers:

$$\begin{aligned} M F'(L^M) &= w, \\ p^A A\, G_{\hat{L^A}}(\hat{L^A}, \hat{S}) A_L &= w. \end{aligned} \tag{7}$$

Using (6) and 7 I obtain:

$$\frac{U_{C^A}}{U_{C^M}} = \frac{M F'(L^M)}{A\, G_{\hat{L^A}}(\hat{L^A}, \hat{S}) A_L}, \tag{8}$$

the equality between marginal rate of substitution and marginal rate of transformation. I now determine the equilibrium share of labor in agriculture and manufacturing. Using (3) in (8):

$$\frac{\nu^A}{\nu^M} \frac{C^M}{C^A - \lambda} = \frac{M F'(L^M)}{A\, G_{\hat{L^A}}(\hat{L^A}, \hat{S}) A_L}. \tag{9}$$

Replacing C^M, C^A and L^M using (5) and (1) and rearranging:

$$\frac{\nu^A}{\nu^M} \frac{F(1 - L^A)}{F'(1 - L^A)} = \frac{1}{A_L} \frac{G(\hat{L^A}, \hat{S}) - \hat{\lambda}}{G_{\hat{L^A}}(\hat{L^A}, \hat{S})}, \qquad \hat{\lambda} = \frac{\lambda}{A}, \tag{10}$$

(10) is the key equation governing the allocation of labor in the economy. Results on the derivatives of L^A with respect to exogenous parameters are summarized in the following proposition. The proofs of the three propositions presented in this paper are given in Appendix A.

Proposition 1 *Consider a competitive market economy whose technology is characterized by* (1) *and* (2)*, whose representative consumer has preferences* (3) *and with market clearing* (5).

Denote σ as the (possibly nonconstant) elasticity of substitution between augmented labor and augmented land in agriculture, and s_S as the competitive income share of land in agricultural *output.*

Then, at an interior solution,

(a) the equilibrium allocation of labor L^A is unique[2]*and satisfy the following condition:*

$$\frac{\nu^A}{\nu^M}\frac{F(1-L^A)}{F'(1-L^A)} = \frac{1}{A_L}\frac{G(\hat{L^A},\hat{S})-\hat{\lambda}}{G_{\hat{L^A}}(\hat{L^A},\hat{S})}, \qquad \hat{\lambda} = \frac{\lambda}{A},$$

(b) the equilibrium allocation of labor L^A reacts to exogenous parameters as following:

$$\frac{\partial L^A}{\partial \nu^A} > 0 \qquad \frac{\partial L^A}{\partial \hat{\lambda}} > 0,$$

if $\underline{\sigma < 1}$,

$$\frac{\partial L^A}{\partial A_L} < 0 \qquad \frac{\partial L^A}{\partial A_S} \lesseqgtr 0 \Leftrightarrow \frac{Y^A-\lambda}{Y^A} \lesseqgtr \sigma,$$

if $\underline{\sigma = 1}$

$$\frac{\partial L^A}{\partial A_L} < 0 \qquad \frac{\partial L^A}{\partial A_S} < 0,$$

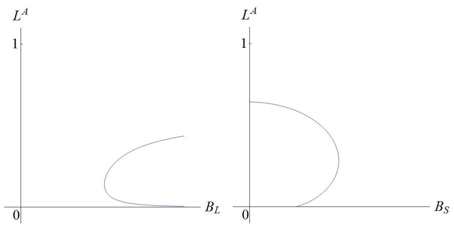
if $\underline{\sigma > 1}$

$$\frac{\partial L^A}{\partial A_L} \lesseqgtr 0 \Leftrightarrow \frac{Y^A-\lambda}{Y^A}\frac{\sigma-s_S}{1-s_S} \lesseqgtr \sigma \qquad \frac{\partial L^A}{\partial A_S} < 0,$$

furthermore, $\frac{\partial L^A}{\partial S}$ *has the same sign as* $\frac{\partial L^A}{\partial A_S}$.

As a starting point, Proposition 1 states that there is a unique way to optimally allocate labor given any set of exogenous parameters. The effects of a marginal increase in Hicks-neutral technical change (A), in the subsistence level (λ) or in the preference for food (ν^A) on the equilibrium value of labor in agriculture are as expected and relatively easy to conceive. In particular, the response of L^A to Hicks-neutral technical change, summarized in the sign of $\frac{\partial L^A}{\partial \hat{\lambda}}$ is to be analyzed as in Matsuyama (1992). On the other hand, understanding the effects of an increase in labor productivity (A_L) or land productivity (A_S) is more challenging and requires discussion. The effect of an increase in land productivity, slightly more intuitive, is studied first. Since in the current framework an increase in land productivity and an increase in land surface are essentially the same, the following discussion uses as illustration the example of an increase in land surface.

[2]For instance, L^A is *not* single-valued when Y^A is a CES with $\sigma < 0$ (the function fails to be concave). The following figures are examples of the shapes that arise in that situation.



Considering a land increase, two mechanisms govern the allocation of labor, a *price effect* and a *complementarity effect*. The *complementarity effect* is the result of a land increase when the price of agricultural goods is kept constant. Holding the price of food fixed, an increase in land will increase the marginal productivity of labor in agriculture since the cross marginal product of G is positive. This rise in the agricultural real wage (equation 7) will immediately attract more labor in agriculture until the wage gap closes. Thus, the complementarity effect always induces a rise in L^A; this is also the only mechanism that would govern labor in a small open economy, since such an economy act as a price taker with respect to world food prices.

The *price effect* is the result of a land increase when the marginal productivity of labor is kept constant. An increase in land increases agricultural production, and under Cobb-Douglas preferences, this create a drop in the relative price of food in terms of manufacturing goods. Workers will then move out of agriculture to prevent the agricultural real wage from falling. Thus, the price effect always induces a drop in L^A.
Understanding the final movement of L^A amounts to asking which effect dominates the other. Proposition 1 states that if the elasticity of substitution between land and labor is greater than one, then the price effect always dominates. In case σ is lower than one, the price effect dominates the complementarity effect *provided the economy is close to a state of subsistence*. To understand why, note that in equilibrium, the price of agricultural goods is related to outputs in a simple way:

$$\frac{\partial p^A}{\partial Y^A} = -\frac{\nu^A}{\nu^M}\frac{Y^M}{(Y^A-\lambda)^2}. \tag{11}$$

Imagine that Y^A comes close to the subsistence level λ. If S decreases and L^A does not increase, then Y^A decreases and equation (11) tells us that the price effect becomes arbitrarily large. The complementarity effect (i.e. the increase in the marginal productivity of labor), on the other hand, stays bounded, since the cross partial derivative $G_{\hat{S}\hat{L^A}}$ is finite by assumption, even close to a state of subsistence.

This explains why the price effect always overcomes the complementarity effect when agricultural output is small enough, and for fixed values of σ, L^A is a decreasing function of S in this region. When Y^A move away from λ, the price effect diminishes and L^A may become an increasing function of S: the relationship is possibly non-monotonic. This closes the discussion about land productivity and surface.

Considering a labor productivity increase, price versus complementarity is still the key idea. A difference however, is that the complementarity effect is now uncertain. Holding the price of food constant, an increase in labor productivity can either increase or decrease the marginal productivity of labor. This comes from the fact that labor productivity both increases the effectiveness of labor through A_L and decreases the productivity of augmented labor on account of diminishing returns. Thus, the complementarity effect can be labor attracting or labor repelling.

The price effect, as a result of increased agricultural production, is as before a drop in the relative price of food and triggers a labor movement out of agriculture. If the complementarity effect is labor repelling, the two effects cumulate and labor productivity pushes labor out of agriculture. If the complementarity effect is labor attracting, the two effects play in opposite directions and the final movement is ambiguous. To better see these effects at work, let us rewrite the sign condition of labor productivity in Proposition 1 in a slightly more intuitive way:

$$\frac{\partial L^A}{\partial A_L} \lesseqgtr 0 \quad \Leftrightarrow \quad \frac{Y^A-\lambda}{Y^A}\,\epsilon_{\frac{w}{p_A},A_L} \lesseqgtr \epsilon_{Y,L^A}.$$

Notwithstanding the role of proximity to subsistence, the complementarity effect is pictured by the right hand elasticity, which is the elasticity of real wages (in food units) with respect to labor productivity and can be positive or negative. The price effect is pictured by the left hand elasticity, the elasticity of output to labor. Additionally, in the present framework of concavity and constant returns to scale:

$$\epsilon_{\frac{w}{p_A},A_L} = 1 - \frac{s_S}{\sigma}.$$

A higher σ increases the response of agricultural wages to labor productivity, possibly turning the elasticity into positive territory and making the complementarity effect play in opposite direction to the price effect. Fortunately, it is possible to sort out clearly the non-ambiguous and the ambiguous case in terms of the elasticity of substitution. When σ is less than one, the price effect always dominate the complementarity effect and labor productivity reduces the agricultural workforce. When σ is greater than one, the price effect will dominate the complementarity effect only if the economy is close enough to a state of subsistence, following the same analysis as before.

It is worth taking time to compare the effect of biased technical change on this closed economy with the results of technical change on an open economy found by Bustos, Caprettini and Ponticelli (2016). I simplify the comparison of these results by positing $\sigma \leq 1$, the most plausible hypothesis *a priori* (cf Section 3). First, in line with Matsuyama's 1992 results, Hicks-neutral technical change decreases agricultural labor in a closed economy, and increases agricultural labor in an open economy. Second, labor-augmenting technical change decreases agricultural labor in a closed economy, and decreases agricultural labor in an open economy provided the elasticity of substitution is lower than the land income share in agriculture[3]. Third, land-augmenting technical change decreases agricultural labor in a closed economy provided households are close enough to a state of subsistence, and increases agricultural labor in an open economy.

2.2 The case of constant elasticity of substitution

Given the central importance of elasticity of substitution in agriculture, a natural illustration of Proposition 1 is the case of a constant elasticity of substitution (CES) function. To facilitate understanding of the results, I state now the functional forms of both agriculture and manufacturing entirely:

$$\begin{aligned} Y^M &= M\,L^M, \qquad (12) \\ Y^A &= A\left[\beta\,(A_L L^A)^{\frac{\sigma-1}{\sigma}} + (1-\beta)\,(A_S S)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \qquad \beta \in (0,1),\ \sigma > 0. \end{aligned}$$

Note that constant returns to scale has been assumed in the manufacturing sector. This is for simplicity, since the analysis could easily carry over to a general concave and strictly increasing function[4]. The following proposition makes clear what additional information on the derivatives of L^A can be inferred from the assumption of constant elasticity of substitution.

[3] An hypothesis termed as "strong complementarity between land and labor" by Bustos, Caprettini and Ponticelli (*ibid.*)

[4] Note that constant returns to scale in the manufacturing sector imply constant returns to scale for the economy as a whole, meaning that all variables can be interpreted in per capita terms. In this case, provided land grows proportionally with labor, the size of the labor force does not affect the share of labor employed in agriculture. If the economy has decreasing returns to scale, (i.e. if Y^M is strictly concave), then an increase in the labor force has an ambiguous effect on the share of the agricultural labor force.

Proposition 2 *Consider a competitive market economy whose technology is characterized by* (12)*, whose representative consumer has preferences* (3) *and with market clearing* (5)*.*

Assume that $A_L = 0$ *is not feasible i.e.* $A_L = 0$ *implies* $Y^A < \lambda$.

Then $L^A(A_L)$ *and* $L^A(A_S)$ *have the following shape:*

if $\underline{\sigma < 1}$,

$L^A(A_L)$ *is decreasing*[5]

$\lambda = 0$, $L^A(A_S)$ *is increasing*
$\lambda > 0$, $L^A(A_S)$ *has at most one turning point, is first decreasing then increasing if the turning point exists*

if $\underline{\sigma = 1}$,

$L^A(A_L)$ *and* $L^A(A_S)$ *are decreasing*

if $\underline{\sigma > 1}$,

$\lambda = 0$, $L^A(A_L)$ *is increasing*
$\lambda > 0$, $L^A(A_L)$ *has one turning point, is first decreasing then increasing*

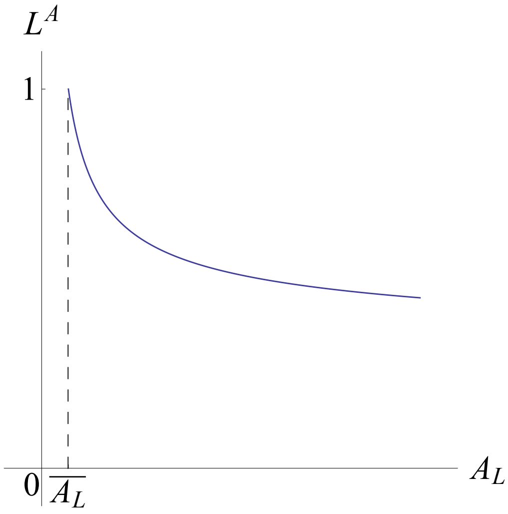
$L^A(A_S)$ *is decreasing*

furthermore, $L^A(S)$ *has the same shape as* $L^A(A_S)$*.*

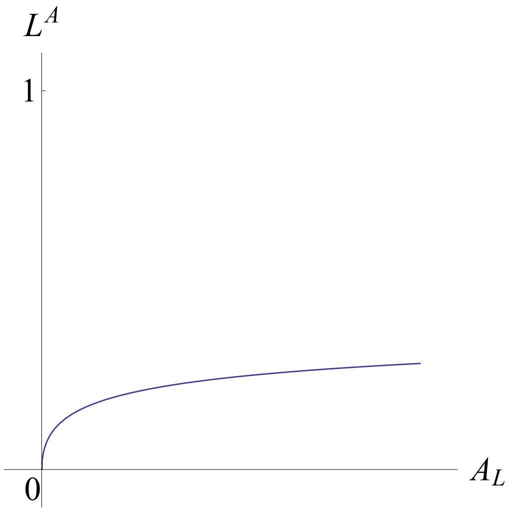
The shape of $L^A(A_S)$ and $L^A(A_L)$ is what you would expect given the preceding discussion on Proposition 1. The additional insight of Proposition 2 is that under constant elasticity of substitution both functions can have at most one turning point. When σ is lower or equal to one, $L^A(A_L)$ is unambiguously decreasing. When σ is greater than one, $L^A(A_L)$ is unambiguously increasing only if there is no subsistence level. If there is a subsistence level, $L^A(A_L)$ is first decreasing then increasing. $L^A(A_S)$ has shapes that mirror the shapes of $L^A(A_L)$ but the inequalities on σ are reversed. One important point, however, is that $L^A(A_S)$ does not necessarily have a turning point when $\sigma < 1$ and $\lambda > 0$. Indeed, when A_S goes to infinity and $\sigma < 1$, agricultural output converges to a finite limit no matter the long run value of L^A. If this limit is equal or lower than what is needed to achieve $\frac{Y^A - \lambda}{Y^A} = \sigma$, the turning point simply never shows up. Appendix A.2 gives a sufficient condition for this turning point to exist. When $\sigma \geq 1$, agricultural output is unbounded and no question of this type arises. Both $L^A(A_L)$ and $L^A(A_S)$ are depicted in Figure 1 and 2, where a bar over a variable denotes the minimum level of the x-axis at which all labor is put to work in agriculture and a double bar over a variable denotes a turning point.

It should be clear that the situation $\lambda = 0$ is unlikely. In this situation, as the productivity of land or labor diminishes, substitution between agricultural and manufacturing goods happens entirely smoothly. It means that close to the y-axis the representative household will consume an amount of food as small as one could imagine, continuously substituting small amounts of food with more manufacturing goods. This surely is not a realistic situation, because individuals would die out of hunger below some threshold. When taking into account this threshold, the substitution is non-smooth. When agricultural output come close to the minimum food

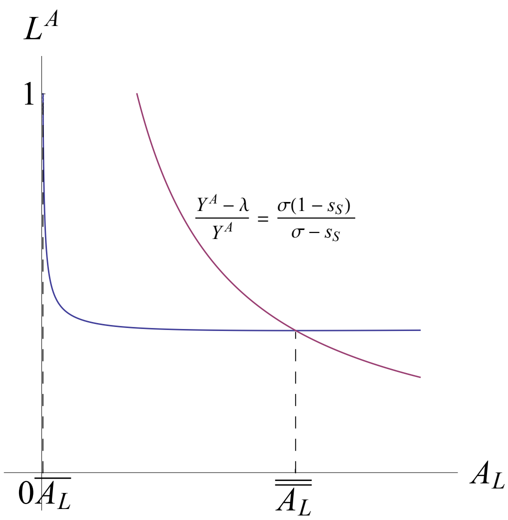
[5] In this paper, monotonicity is always meant strictly.



(a) $\sigma \leq 1$

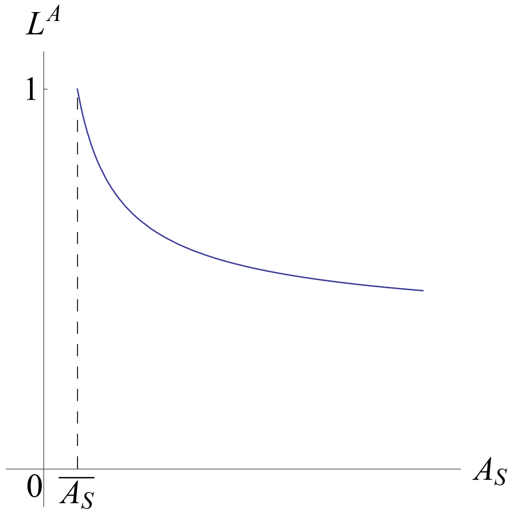


(b) $\sigma > 1$ *and* $\lambda = 0$

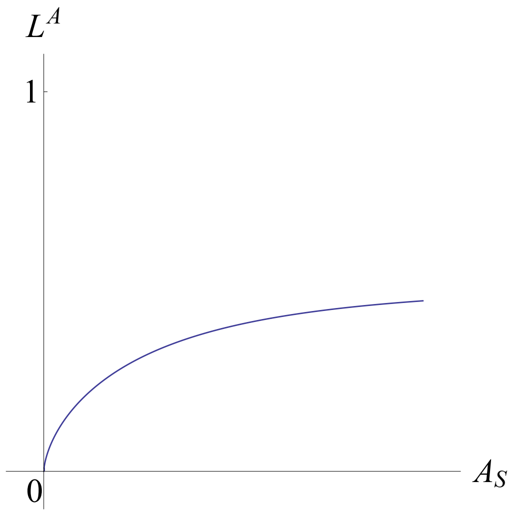


(c) $\sigma > 1$ *and* $\lambda > 0$

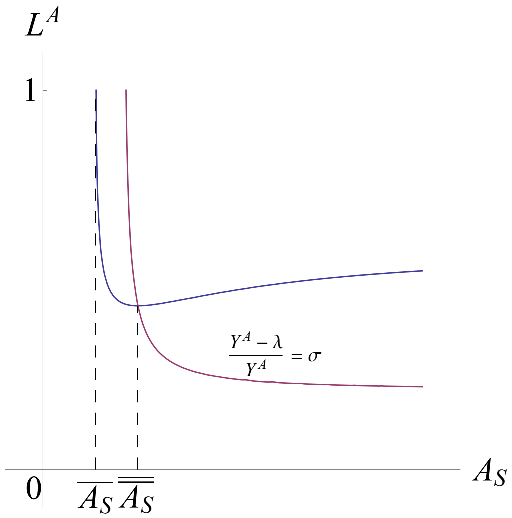
Figure 1: *Labor allocation as a function of labor productivity in agriculture*



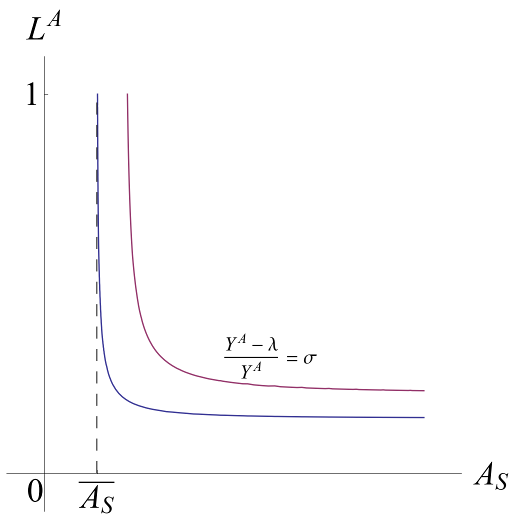
(a) $\sigma \geq 1$



(b) $\sigma < 1$ *and* $\lambda = 0$



(c) $\sigma < 1$ *and* $\lambda > 0$



(d) $\sigma < 1$ *and* $\lambda > 0$ *(no turning point)*

Figure 2: *Labor allocation as a function of land productivity in agriculture*

requirement λ, shifting additional labor from agriculture to industry would cause agricultural output to equal λ and the marginal utility of agricultural goods to become infinite. Labor in the agricultural sector will then increase so that the representative household can keep above λ. In words, when A_S or A_L is close to zero, even if the marginal productivity of a laborer *in terms of agricultural output* is virtually nil, this laborer cannot possibly be put to work in manufacturing because that would put the population in a state of starvation.

To conclude, no matter how much substitution possibilities between $\hat{L^A}$ and $\hat{S}$ there are, there is always a neighborhood of zero, corresponding to a close proximity to subsistence, where L^A is a strictly decreasing function of A_L,A_S, and S. When the economy moves away from this state of subsistence, either land or labor productivity can cease to produce structural change depending on whether σ is greater or lower than one.

After having inferred the precise relationship of agricultural labor with land and labor productivity, I discuss the *relative* effectiveness of land and labor productivity, first with respect to elasticity of substitution, and second with respect to proximity to subsistence. To this purpose, I study the elasticities of L^A with respect to A_L, A_S and A since their unitless property is ideal to reveal the core economic concepts driving structural change. The exact derivative of L^A with respect to $\hat{S}$ is the following:

$$\frac{\partial L^A}{\partial \hat{S}} = \frac{(A_L)^{-1}\left(\dfrac{Y^A-\lambda}{Y^A}-\sigma\right)}{\dfrac{Y^A-\lambda}{Y^A}\dfrac{\hat{S}}{\hat{L^A}}+\gamma\left(\dfrac{\hat{S}}{\hat{L^A}}\right)^{\frac{1}{\sigma}}}, \tag{13}$$

$$with \quad \gamma = \frac{\sigma}{\nu^M}\frac{\beta}{(1-\beta)}.$$

Now turning equation (13) into an elasticity of labor with respect to augmented land (i.e. $\epsilon_{L^A,\hat{S}} = \frac{\hat{S}}{L^A}\frac{\partial L^A}{\partial \hat{S}}$) gives:

$$\epsilon_{L^A,A_S} = \epsilon_{L^A,S} = \epsilon_{L^A,\hat{S}} = \frac{\dfrac{Y^A-\lambda}{Y^A}-\sigma}{\dfrac{Y^A-\lambda}{Y^A}+\dfrac{\sigma}{\nu^M}\dfrac{1-s_S}{s_S}}, \tag{14}$$

where s_S is as before the competitive income share of land in agricultural output. If A_S pushes labor out of agriculture then the elasticity is negative, if A_S attracts labor in agriculture then the elasticity is positive. The same method can be applied to both labor productivity and total factor productivity:

$$\epsilon_{L^A,A_L} = \frac{\dfrac{\sigma-s_S}{s_S}\left(\dfrac{Y^A-\lambda}{Y^A}-\dfrac{\sigma(1-s_S)}{\sigma-s_S}\right)}{\dfrac{Y^A-\lambda}{Y^A}+\dfrac{\sigma}{\nu^M}\dfrac{1-s_S}{s_S}}, \tag{15}$$

$$\epsilon_{L^A,A} = \frac{-\dfrac{\lambda}{Y^A}\dfrac{\sigma}{s_S}}{\dfrac{Y^A-\lambda}{Y^A}+\dfrac{\sigma}{\nu^M}\dfrac{1-s_S}{s_S}}. \tag{16}$$

As expected there is a natural relationship between the three elasticities presented above:

$$\epsilon_{L^A,A} = \epsilon_{L^A,A_L} + \epsilon_{L^A,A_S}. \tag{17}$$

The effect of a relative increase in total factor productivity is the sum of relative increases in both labor and land productivity. Equations (14) and (15) show that these relative increases can be calibrated easily using just four economic indicators: the elasticity of substitution σ, the proximity to subsistence $\frac{Y^A-\lambda}{Y^A}$, the income share of land s_S, and the Cobb-Douglas parameter ν^M, which can be interpreted as before as the long-run share of spending devoted to non-food items. Before turning to the calibration however, it is useful to see how their values change with σ and agricultural output Y^A.

Equations (14) and (15) are striking by their simplicity but could be somewhat misleading to the reader in inducing to believe that σ affects the elasticities in a simple way. Indeed, one should keep in mind that σ not only enters directly in the equation, but also indirectly through Y^A and s_S. Thus the total derivatives of ϵ_{L^A,A_L}, ϵ_{L^A,A_S} and $\epsilon_{L^A,A}$ with respect to σ are extremely tedious, and do not provide clear results. However, their partial derivatives with respect to σ, that is, *holding agricultural output and the income share of land constant*, are easily computed and provide key insights into the role of σ. The spirit of studying the partial effect of σ is to be able to compare the effectiveness of different sources of structural change in settings where nothing changes (i.e. the level of development, the relative scarcity of factors) except for the underlying elasticity of substitution. By the same spirit, it is possible the evaluate the partial effect of an increase in agricultural output Y^A, while holding constant the income share of land s_S. This would allow the comparison of economies with the same relative factor scarcities but at different levels of development. Proposition 3 below summarizes the key insights of the analysis of partial effects.

Proposition 3 *Consider ϵ_{L^A,A_S}, ϵ_{L^A,A_L} and $\epsilon_{L^A,A}$ as computed in equations* (14), (15) *and* (16), *with* $\lambda > 0$.

(a) When evaluating the partial effect of a change in σ (i.e. holding Y^A and s_S constants):

ϵ_{L^A,A_L} is increasing concave,

ϵ_{L^A,A_S} and $\epsilon_{L^A,A}$ are decreasing convex.

(b) When evaluating the partial effect of a change in Y^A (i.e. holding s_S constant):

ϵ_{L^A,A_L} is increasing concave if $\sigma > s_S \nu^A$ and decreasing convex otherwise,

ϵ_{L^A,A_S} and $\epsilon_{L^A,A}$ are increasing concave.

It is clear that labor productivity effectiveness benefits from a high elasticity of substitution while land productivity effectiveness benefits from a low elasticity of substitution. Figure 3 plots elasticities (14) to (16) as a function of the direct effect of σ. In Figure 3 panel (a) where λ has been set to zero, ϵ_{L^A,A_L} and ϵ_{L^A,A_S} sum to zero and $\epsilon_{L^A,A}$ is thus merged with the horizontal axis. When σ is nil,ϵ_{L^A,A_L} is equal to -1 and ϵ_{L^A,A_S} is equal to 1. This is only natural: in this situation the CES becomes a Leontief production function and augmented land is proportional to augmented labor. Before σ reaches one, land productivity is pushing labor out of agriculture while labor productivity attracts labor in agriculture. At $\sigma = 1$ both elasticities are nil and the role are reversed thereafter. This clearly shows the importance of differentiating between sources of productivity growth in understanding structural change.

Figure 3 (b) and (c) show that a positive subsistence level has the effect of pushing down all the curves downward, so that $\epsilon_{L^A,A}$ enters into negative territory. Panel (b) is an example of elasticities behavior when the economy is relatively far away from a state of subsistence. Which type of productivity pushes labor out of agriculture still clearly depends on whether σ is higher or lower than one. However panel (c) is an example of what happen when the economy is relatively close to a state of subsistence. With the exception of a small intervall close to zero, both elasticities are largely negative. This illustrates the fact that close to subsistence the choice between different types of productivity improvements does not matter.

Figure 4 plots elasticities (14) to (16) as a function of agricultural output, setting the income share of land equal to 0.5 (this assumption ensures that ϵ_{L^A,A_L} and ϵ_{L^A,A_S} start at the same initial value and makes comparability easier). An expansion of agricultural output with constant income shares means that the ratio of augmented land to augmented labor stays constant. Panel (a), (b) and (c) show that the elasticity of substitution affects the type of productivity improvements that will become ineffective (i.e. attracts instead of pushes agricultural labor) over the course of development. The inelastic case corresponds to land productivity becoming ineffective while labor is concerned in the elastic case. Finally, the Cobb-Douglas economy of panel (b) is an economy were both types of productivity improvements stay effective over time.

3 An illustration of the model using data on income shares

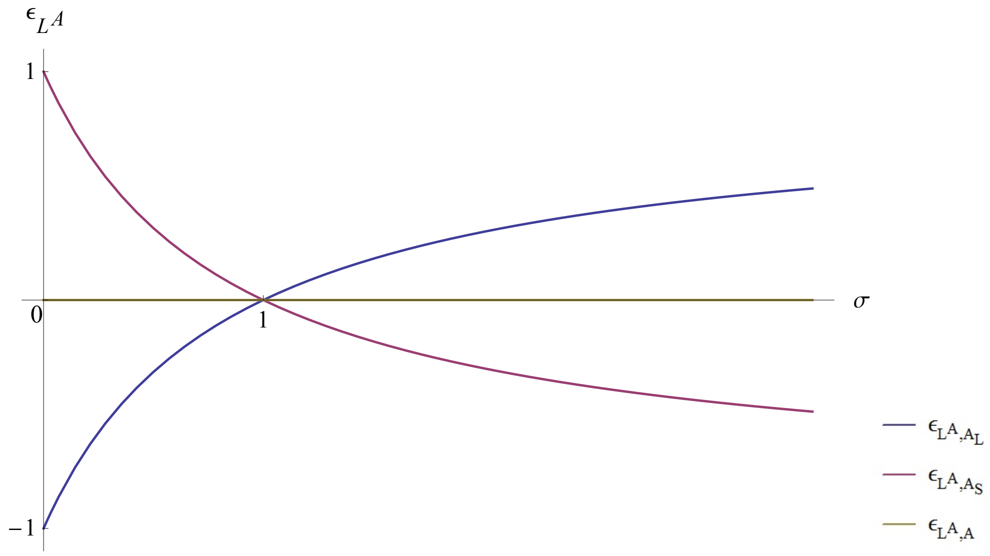
3.1 Data and methods

In this section I calibrate the elasticities of agricultural labor derived in section 2.2 (equations (14), (15) and (16)) to investigate the effectiveness of labor and land productivity changes in the agriculture of the developing world. Data sources and methodological choices are discussed first, then results are summarized.

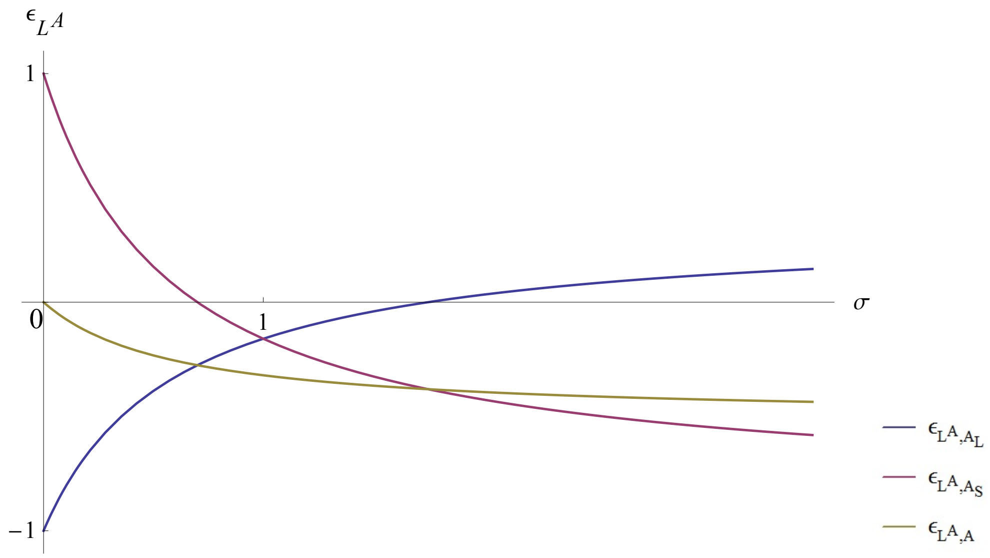
Before getting into the calibration details, a note of caution is in order. The model describes a closed economy, and the calibration should be interpreted as such. The question of whether an economic unit is approximately described as closed or open is practically a question of size: small or insular countries usually have a much higher degree of opening than large countries or world regions. Along these lines, the calibration results of a country such as Vietnam (with exports and imports averaging 100% of its GDP in 2017 according to the World Bank) cannot be taken as seriously as the calibration results of a regional ensemble such as East Asia & Pacific.

Table 1 presents the data sources used for calibrating ϵ_{L^A,A_L}, ϵ_{L^A,A_S} and $\epsilon_{L^A,A}$, as well as for weighting country level data in regional computations. Clearly the key parameter lacking data support is the elasticity of substitution σ. First, geographical coverage is limited to roughly twenty countries, each study having its own estimation method carried over different time periods. Without sufficient localized information on σ, even for broad regions of the world, this study has chosen to assign to all countries the same value of σ. Second, in the model of this paper augmented land and augmented labor are understood as broad categories encompassing all the inputs useful for agricultural production. Elasticities of substitution in the literature are estimated at a lower level of aggregation, usually involving five or more input categories. Nonetheless, available evidence (Table (2)) suggests an elasticity of substitution between labor and land within a range of 0.2 to 1.2, inclined on average toward the inelastic case.

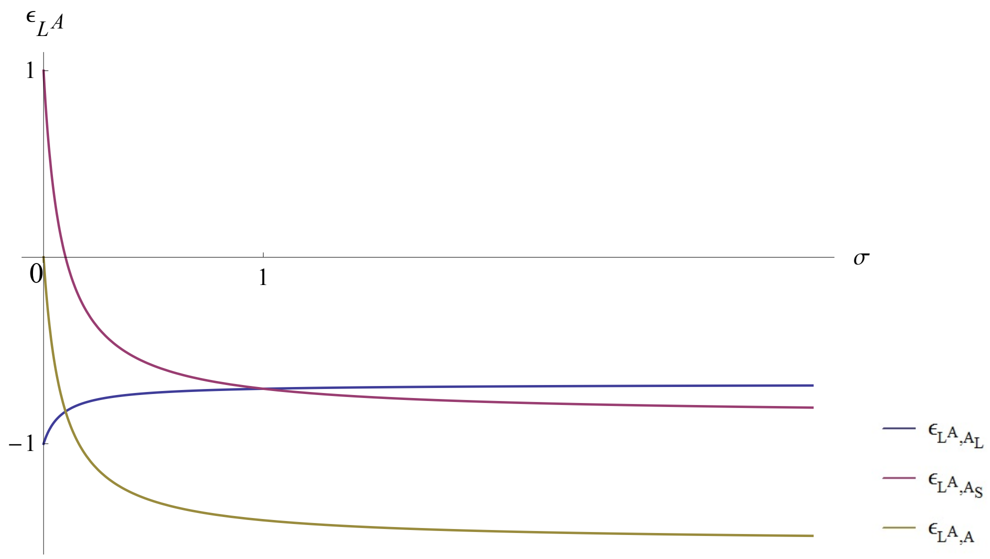
Analogously, all countries have the same Cobb-Douglas parameter ν^M. Since ν^M is inherently a long run variable and since our analysis focuses on developing countries that for the most part do not have fully achieved structural change, it is difficult to guess ν^M at a country level. In this study, I have computed ν^M as the share of final consumption devoted to non-food



(a) $\lambda = 0$

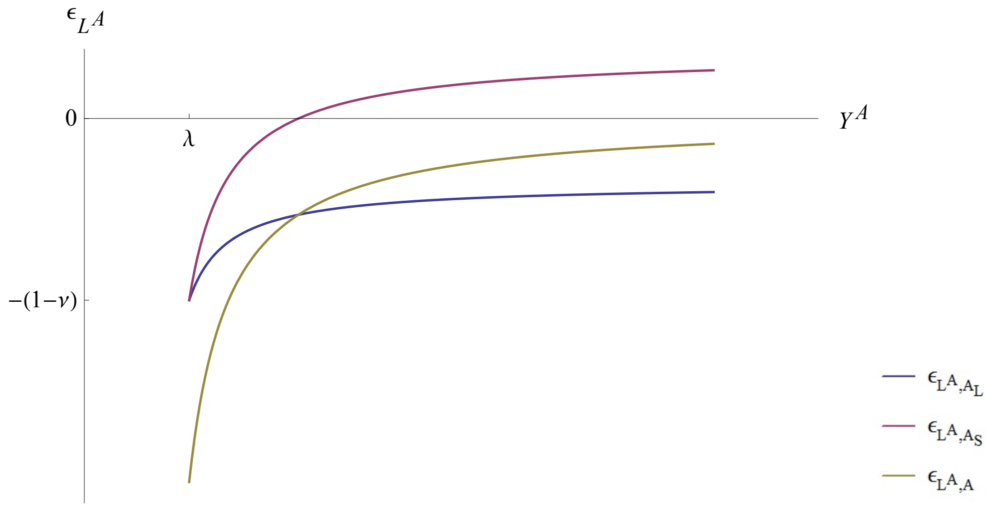


(b) $\lambda > 0$, *far from the subsistence level*

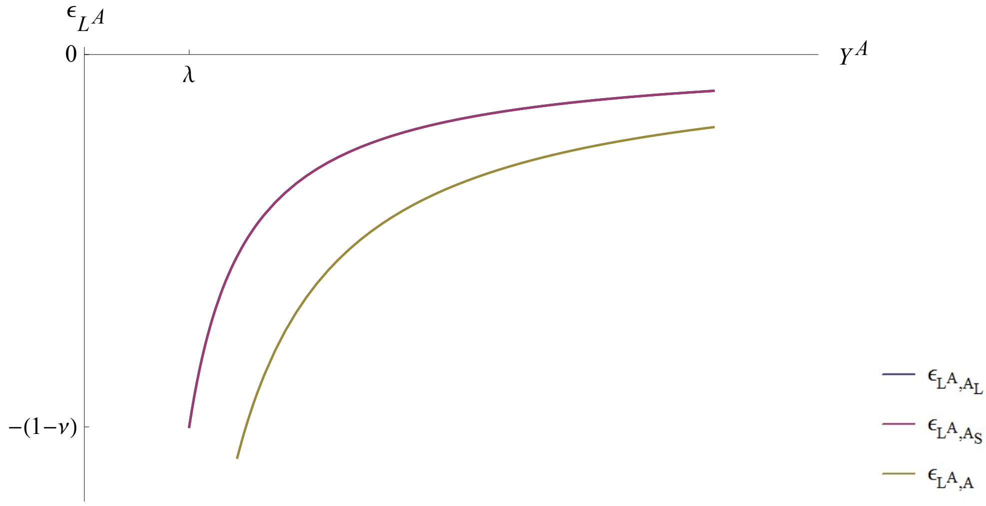


(c) $\lambda > 0$, *close to the subsistence level*

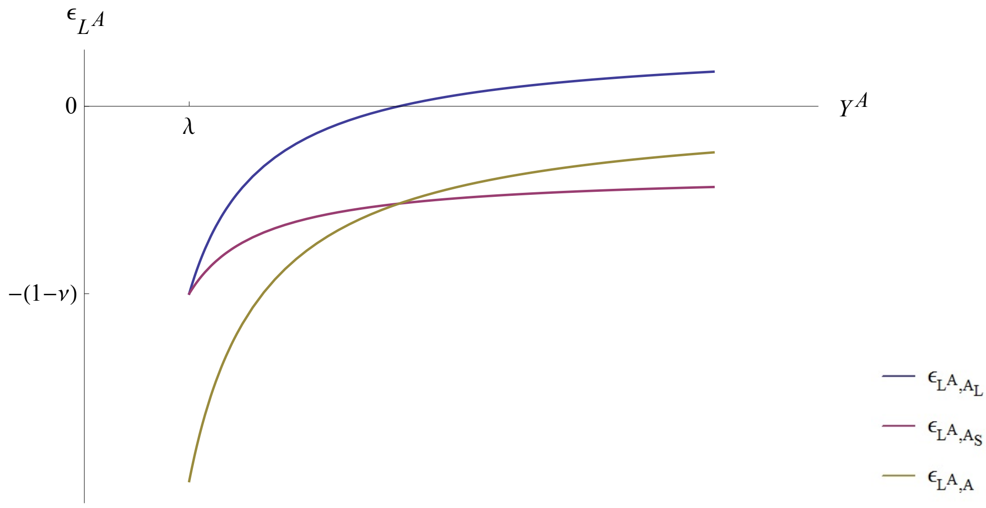
Figure 3: *Various elasticities as a function of the partial effect of sigma*



(a) $\sigma < 1$



(b) $\sigma = 1$



(c) $\sigma > 1$

Figure 4: *Various elasticities as a function of the partial effect of agricultural output, income share of land=0.5*

items among OECD countries, which as fully industrialized countries are deemed to provide a good approximation of the long run situation. The resulting value of ν^A is roughly 0.11.

Data on income shares come from Fuglie (2015) using the most recent estimates of 2011-2012. Fuglie draws on 19 studies to assign income shares to 17 broad regions of the world, assuming small economies behave similarly to large economies like Brazil or India for which estimates are available. Agricultural inputs are divided into six classes: labor, land, livestock capital, fixed capital (e.g. agricultural machines), crop materials (e.g. fertilizers) and livestock materials (e.g.feed). As documented in Table 1 the income share of augmented labor is assumed to be the sum of the income shares of labor and fixed capital and the income share of augmented land sums up the remaining inputs.

Finally, a few words on the empirical counterpart of λ. λ is measured using FAO estimates of the minimum dietary energy requirement (MDER) at a national scale. The MDER is expressed in kilocalories and reflects energy needs consistent with preserving good health in the long run (Naiken 2003, Wanner *et alii* 2014). It is first computed by sex and age groups on the basis of the reference body weight and physical activity, and then each group energy requirement is weighted by the proportion of that group in the total population. Happily, the MDER-though not estimated primarily for the purpose of economic analysis-fits closely the idea of the subsistence level of a representative household[6]. To obtain the indicator of proximity to subsistence, I compare the MDER with actual food supply as estimated by the FAO. Both measurements are expressed in kilocalories per capita per day.

Table 1: *Data sources for the calibration of* ϵ_{L^A,A_L}, ϵ_{L^A,A_S} *and* $\epsilon_{L^A,B}$

Concept	Data item	Data source	Available at country level
Agricultural output per capita: Y^A	Food supply in kilocalories per capita per day, 2011-2012 average	Food and Agriculture Organization (FAO)	Yes
Subsistence level: λ	Minimum Dietary Energy Requirement (MDER) in kilocalories per capita per day, 2011-2012 average	FAO	Yes
Income share of land in agriculture: s_S	Sum of income shares: land, livestock capital, crop materials, livestock materials	Fuglie (2015)	Yes
Cobb-Douglas preference parameter: ν^M	Weighted average of the share of final household consumption devoted to non-food expenditures among OECD countries[2], 2016	OECD	No
Elasticity of substitution: σ	Set to 0.2, 0.5 and 1.2	Table 2	No
Agricultural labor	Employment in agriculture (paid + self employment), 2011-2012 average	International Labor Organization	Yes
Agricultural output	Net production value of agriculture in constant 2004-2006 international dollars	FAO	Yes

[6]This conceptual proximity, however, does not necessarily mean that the MDER concides with the mathematical definition of λ in (3), which implies that when $C^A = \lambda$ the household income is entirely spent on food.

Table 2: *Estimates of the elasticity of substitution between labor and land*

Author	Year	Country	Period	Additional Specifications	Estimate
Bilkis Raihana	2012	Bangladesh	1973-1995	non-homothetic structure with technical change	(-0.0615)
K. Melfou, A. Theocharopoulos and E. Papanagiotou	2008	Greece	1990-1996		0.256
			1969-1996		0.409
D.D. Tewari and Shashi Kant	2005	South Africa	1965-1997		15.63
Klaus Salhofer	2000	Europe	Meta-analysis of 32 studies		0.5
				corrected for outliers	0.5
				corr. for outliers & weighted	0.3
Subhash C. Sharma	1991	South Korea	1949-1971		1,1982-1,3073
			1918-1938 and 1949-1971		1,0811-1,1326
Subhash C. Ray	1982	United States	1939-1977	Hicks-neutral technical change	0.7482
			1977		0.6196
Wayne Thirsk	1974	Colombia	1968	Rice	0.36-1.18
				Cotton	0.02-0.64
				Corn	0.28-0.8
				Sesame, Soybeans and Sorghum	0.12-0.89
				Wheat and Barley	(-0,83)-0,87
Hans P. Binswanger	1974	United States	1949, 1954, 1959, 1964		0.204

Table 3: *Results for broad regions*

Region	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
Central Asia	0.43	0.47	0.2	-0.70	0.28	-0.42
			0.5	-0.53	-0.11	-0.64
			1.2	-0.40	-0.42	-0.81
East Asia & Pacific	0.37	0.44	0.2	-0.70	0.23	-0.47
			0.5	-0.56	-0.14	-0.70
			1.2	-0.45	-0.41	-0.86
Europe	0.42	0.54	0.2	-0.71	0.33	-0.38
			0.5	-0.52	-0.11	-0.63
			1.2	-0.36	-0.48	-0.84
L. America & Carib.	0.38	0.40	0.2	-0.69	0.20	-0.49
			0.5	-0.56	-0.13	-0.69
			1.2	-0.47	-0.36	-0.83
M. East & N. Africa	0.43	0.41	0.2	-0.68	0.29	-0.39
			0.5	-0.52	-0.07	-0.59
			1.2	-0.39	-0.34	-0.73
North America	0.46	0.68	0.2	-0.74	0.45	-0.29
			0.5	-0.49	-0.06	-0.55
			1.2	-0.20	-0.67	-0.87
South Asia	0.27	0.38	0.2	-0.71	0.11	-0.61
			0.5	-0.62	-0.19	-0.81
			1.2	-0.56	-0.38	-0.93
Sub-Saharan Africa	0.30	0.43	0.2	-0.73	0.08	-0.65
			0.5	-0.63	-0.25	-0.87
			1.2	-0.56	-0.45	-1.01
World	0.37	0.46	0.2	-0.71	0.16	-0.55
			0.5	-0.59	-0.17	-0.76
			1.2	-0.50	-0.40	-0.91

3.2 Results

ϵ_{L^A,A_S}, ϵ_{L^A,A_L} and $\epsilon_{L^A,A}$ are calibrated at a country level for three values of σ: 0.2 ; 0.5 ; 1.2. These country results, as well as the computed proximity to subsistence and the income share of land, are available in the Online appendix: Country results. While 0.5 could be considered the most reasonable guess given the meta-analysis of Klaus Salhofer (2000) (Table (2)), 0.2 and 1.2 are plausible lower and upper bounds. Table (3) gives calibrations of ϵ_{L^A,A_S}, ϵ_{L^A,A_L} and $\epsilon_{L^A,A}$ at a *regional level*, where country level elasticities are weighted by their share in agricultural labor[7][8].

I focus the following discussion on ϵ_{L^A,A_S} and ϵ_{L^A,A_L}, as $\epsilon_{L^A,A}$ is just a sum. Table (3) shows that when σ is equal to 1.2, labor and land productivities have similar values around (-0.4) except for North America and South Asia. In this situation, both productivity improvements are expected to be equally effective. One notable exception is North America where land improvements (-0.67) is considerably more effective than labor improvements (-0.2), and South Asia where labor improvements still dominates. When σ is equal to 0.5, labor improvements hover around (-0.5) and is three to four times more effective than land improvements everywhere in the world. Regions where land improvements remain substantially effective are Sub-Saharan Africa (-0.25) and South Asia (-0.19). Finally, when σ reaches 0.2, land productivity yields positive elasticities in every regions, close to 0.1 in Sub-Saharan Africa and South Asia, but frequently closer to 0.3. Labor productivity reaches (-0.7) and drives entirely the structural transformation, while land productivity (or land extension) slows it.

In every case labor productivity is consistently negative, leading to the conclusion that it is everywhere an effective means of structural transformation. As for land productivity, given that Sub-Saharan Africa and South Asia keep consistently low values for this item, even for low sigmas, it seems reasonable to believe that land productivity contribute to structural change in these regions. However, one can raise doubts as to its effectiveness in other regions of the developing world, that is, in other parts of Asia and Pacific, in Latin America and in the MENA region.

Figures (5) to (13) give a visual overview of the country level calibration by dividing the distribution of elasticities into four quartiles. Unsuprinsingly, developing countries always belong to the higher quartiles. A low σ (for labor productivity) or a high σ (for land productivity) however put some developed regions like North America and Europe in the highest quartiles of the distribution. A striking feature about land productivity is the vast color change occuring when σ drops from 0.5 to 0.2. Almost every regions of the world goes into positive territory except notably some parts of Sub-Saharan Africa and a few isolated countries, North Korea, Tajikistan and Haiti, due to their high proximity to subsistence.

4 Conclusion

The purpose of this study was to understand under which circumstances different sources of productivity in agriculture contributes to structural transformation out of the agricultural sector. With Cobb-Douglas preferences and a general framework of production, I showed that when an economy is close to a state of subsistence, i.e. food consumption is close to the subsistence level, both labor and land productivity are effective as a mean of shifting labor in the manufacturing sector. As the economy gets further away from the state of subsistence, taking into account

[7] This weighting rule relies on the hypothesis that each country face the same relative increase in productivity. More generally, if $y = \sum_I y_i$, $x = \sum_I x_i$ and $\frac{dx_i}{x_i} = \frac{dx_j}{x_j}$ $\forall i, j \in I$, then $\epsilon_{y,x} = \frac{1}{y} \sum_I y_i \, \epsilon_{y_i,x_i}$.

[8] For broad regions, proximity to subsistence and income share of land have been computed by weighting country level data using their share in agricultural output.

the elasticity of substitution between augmented land and augmented labor is critical. If the production technology is Cobb-Douglas, both labor and land productivity improvements stay effective. If the production technology is inelastic ($\sigma < 1$) labor productivity stays effective on the long run but land productivity ends up having the opposite effect, attracting labor in agriculture due to the strength of the complementarity between land and labor. If the production technology is elastic ($\sigma > 1$), land productivity stays effective but labor productivity will end up attracting labor in agriculture due to the high positive response of agricultural wages to labor productivity. Besides, the elasticity of substitution also provides information on the relative effectiveness of land and labor productivities, a higher σ giving more quantitative importance to labor productivity than to land productivity.

I then calibrated the model with three scenarios of substitution to investigate the most effective sources of structural change in today's developing countries: labor productivity is deemed effective everywhere, but only in Sub-Saharan Africa, South Asia, and a handful countries close to subsistence, is land productivity most likely an effective means of structural transformation. However, more localized, country-level information on the elasticity of substitution between land and labor and the income share of land would be required to reduce the set of possible outcomes and strengthen this empirical conclusion. Also, an econometric analysis of the relative importance of labor versus land productivity improvements in structural transformation would be a useful exercise to test the theoretical predictions presented here.

A Proofs

A.1 Proof of Proposition 1

Proof of the uniqueness of L^A

Given that the market equilibrium decentralize the optimal solution, one might as well write L^A as the solution to:

$$\begin{aligned} Max_{L^A} \quad & U(Y^A(L^A), Y^M(L^A)) \\ s.t. \quad & 0 \leq L^A \leq 1. \end{aligned}$$

Since the constraint set for this problem is compact, $U(L^A)$ is continuous as a composition and product of continuous functions, then a solution exists by the Weierstrass theorem. Additionally the constraint set for this problem is convex, so the solution is unique if $U(L^A)$ is strictly concave. Using the utility function (3) and the set of assumptions (2), it can be easily shown that

$$\frac{\partial^2 U}{\partial {L^A}^2} < 0, \tag{18}$$

proving that L^A must be unique.

Proof of L^A response to exogenous changes

Let us rewrite equation (10) using a new notation:

$$f(L^A, \nu^A) = \frac{1}{A_L}\, g(\hat{S}, \hat{L^A}, \hat{\lambda}), \tag{19}$$

with

$$f(L^A, \nu^A) = \frac{\nu^A}{\nu^M} \frac{F(L^M)}{F'(L^M)}, \tag{20}$$

$$g(\hat{S}, \hat{L^A}, \hat{\lambda}) = \frac{G(\hat{L^A}, \hat{S}) - \hat{\lambda}}{G_{\hat{L^A}}(\hat{L^A}, \hat{S})}. \tag{21}$$

f and g have the following derivatives:

$$f_{L^A} = \frac{\nu^A}{\nu^M}\left(\frac{FF''}{(F')^2} - 1\right) < 0,$$

$$f_{\nu^A} = \frac{1}{(\nu^M)^2}\ \frac{F}{F'} > 0,$$

$$g_{\hat{L^A}} = 1 + \frac{(G - \hat{\lambda})(-G_{\hat{L^A}^2})}{(G_{\hat{L^A}})^2} > 0, \tag{22}$$

$$g_{\hat{S}} = \frac{G_{\hat{S}} G_{\hat{L^A}} - (G - \hat{\lambda}) G_{\hat{S}\hat{L^A}}}{(G_{\hat{L^A}})^2} \geq 0 \ \text{ or } \ < 0,$$

$$g_{\hat{\lambda}} = -\frac{1}{G_{\hat{L^A}}} < 0,$$

where the signs are deduced from the set of assumptions (2).
By implicit differentiation of L^A :

$$\frac{\partial L^A}{\partial \nu^A} = -\frac{f_{\nu^A}}{f_{L^A} - g_{\hat{L^A}}} > 0, \tag{23}$$

$$\frac{\partial L^A}{\partial \hat{\lambda}} = \frac{\frac{1}{A_L}\, g_{\hat{\lambda}}}{f_{L^A} - g_{\hat{L^A}}} > 0, \tag{24}$$

$$\frac{\partial L^A}{\partial \hat{S}} = \frac{\frac{1}{A_L}\, g_{\hat{S}}}{f_{L^A} - g_{\hat{L^A}}}, \tag{25}$$

$$\frac{\partial L^A}{\partial A_L} = \frac{\frac{L^A}{A_L}\left(g_{\hat{L^A}} - \frac{g}{\hat{L^A}}\right)}{f_{L^A} - g_{\hat{L^A}}}. \tag{26}$$

To get the sign condition of $\frac{\partial L^A}{\partial \hat{S}}$, rearrange $g_{\hat{S}}$ in the following way:

$$g_{\hat{S}} = \frac{G G_{\hat{S}\hat{L^A}}}{(G_{\hat{L^A}})^2}\left(\frac{G_{\hat{L^A}} G_{\hat{S}}}{G G_{\hat{S}\hat{L^A}}} - \frac{G - \hat{\lambda}}{G}\right), \tag{27}$$

where the cross marginal product of G is positive. Indeed, by homogeneity of degree one

$$G_{\hat{S}\hat{L^A}} = -\frac{\hat{L^A}}{\hat{S}} G_{\hat{L^A}^2} > 0, \tag{28}$$

since $G_{L^A{}^2} < 0$ by (2). Hence the sign of $g_{\hat{S}}$ depends on the term in brackets. But the first term within the brackets is simply the elasticity of substitution for functions with constant returns to scale:

$$\frac{G_{\hat{L^A}} G_{\hat{S}}}{G G_{\hat{S}\hat{L^A}}} = \sigma\left(\frac{\hat{L^A}}{\hat{S}}\right), \tag{29}$$

where $\frac{\hat{L^A}}{\hat{S}}$ is an argument of σ. Droping the argument of σ for convenience, this yields the following sign condition for g_I:

$$g_{\hat{S}} \gtreqless 0 \quad \Leftrightarrow \quad \frac{Y^A - \lambda}{Y^A} \lesseqgtr \sigma, \tag{30}$$

and finally:

$$\frac{\partial L^A}{\partial \hat{S}} \lesseqgtr 0 \quad \Leftrightarrow \quad \frac{Y^A - \lambda}{Y^A} \lesseqgtr \sigma. \tag{31}$$

The implications of different values of σ are easily deduced from (31).
To get the sign condition of $\frac{\partial L^A}{\partial A_L}$, rearrange $g_{\hat{L^A}} - \frac{g}{\hat{L^A}}$ in the following way:

$$g_{\hat{L^A}} - \frac{g}{\hat{L^A}} = 1 - \frac{G - \hat{\lambda}}{\hat{L^A} G_{\hat{L^A}}}\left(1 + \frac{\hat{L^A} G_{\hat{L^A}^2}}{G_{\hat{L^A}}}\right). \tag{32}$$

Using homogeneity of degree one, it can be shown that

$$\frac{\hat{L^A} G_{\hat{L^A}^2}}{G_{\hat{L^A}}} = -\frac{s_S}{\sigma}. \tag{33}$$

Now using (33) and the fact that $s_{L^A} = \frac{\hat{L^A} G_{\hat{L^A}}}{G}$:

$$g_{\hat{L^A}} - \frac{g}{\hat{L^A}} = 1 - \frac{G - \hat{\lambda}}{G} \frac{1 - \frac{s_S}{\sigma}}{s_{L^A}}, \tag{34}$$

slightly rearranging and using the fact that $s_{L^A} = 1 - s_S$:

$$g_{\hat{L^A}} - \frac{g}{\hat{L^A}} = 1 - \frac{G - \hat{\lambda}}{G} \frac{\sigma - s_S}{\sigma(1 - s_S)}, \tag{35}$$

this gives the sign condition for $g_{\hat{L^A}} - \frac{g}{\hat{L^A}}$:

$$g_{\hat{L^A}} - \frac{g}{\hat{L^A}} \gtreqless 0 \quad \Leftrightarrow \quad \frac{Y^A - \lambda}{Y^A} \frac{\sigma - s_S}{1 - s_S} \lesseqgtr \sigma, \tag{36}$$

and finally:

$$\frac{\partial L^A}{\partial A_L} \lesseqgtr 0 \quad \Leftrightarrow \quad \frac{Y^A - \lambda}{Y^A} \frac{\sigma - s_S}{1 - s_S} \lesseqgtr \sigma. \tag{37}$$

Once again, the implications of different values of σ are easily deduced. In particular, one can see clearly the consequences of $\sigma \leq 1$ using the equivalent inequality:

$$\frac{Y^A - \lambda}{Y^A} \frac{1 - \frac{s_S}{\sigma}}{1 - s_S} \lesseqgtr 1.$$

A.2 Proof of Proposition 2

All cases where either $L^A(A_L)$ or $L^A(A_S)$ is monotonic derive directly from the results of Proposition 1.

<u>$\sigma < 1$ and $\lambda > 0$</u>

$L^A(A_S)$ is non-monotonic in this case. I give sufficient conditions for the existence of a turning point, then the proof of its uniqueness. $\frac{\partial L^A}{\partial A_S}$ can be deduced from (13):

$$\frac{\partial L^A}{\partial A_S} = \frac{\frac{Y^A - \lambda}{Y^A} - \sigma}{\frac{Y^A - \lambda}{Y^A} \frac{\hat{S}}{\hat{L^A}} + \gamma \left(\frac{\hat{S}}{\hat{L^A}} \right)^{\frac{1}{\sigma}}} \frac{S}{A_L}.$$

Solving for a turning point directly on the derivative of $L^A(A_S)$ is difficult given that it is only implicitly defined. Another simple method is to show that the curve $L^A(A_S)$ and the curve implicitly defined by $\frac{Y^A - \lambda}{Y^A} = \sigma$ intersect at most once.

Let us define $h(A_S) = L^A(A_S) - g(A_S)$, where $g(A_S)$ is the value of L^A implicitly defined by:

$$\frac{Y^A - \lambda}{Y^A} = \sigma \quad \Leftrightarrow \quad G = \frac{\hat{\lambda}}{1 - \sigma},$$

an immediate implication of the definition of h is the following:

$$\begin{aligned}
& h(A_S) \gtreqless 0, \\
\Leftrightarrow \quad & L^A(A_S) \gtreqless g(A_S), \\
\Leftrightarrow \quad & \frac{Y^A - \lambda}{Y^A} \gtreqless \sigma \quad \text{since } \frac{Y^A - \lambda}{Y^A} \text{ is increasing in } L^A, \\
\Leftrightarrow \quad & \frac{\partial L^A}{\partial A_S} \gtreqless 0,
\end{aligned}$$

$h(A_S)$ and $\frac{\partial L^A}{\partial A_S}$ have the same sign.

Let us define $\bar{A_S}$ implicitly by $L^A(\bar{A_S}) = 1$. The existence of $\bar{A_S}$ when $\sigma < 1$ results from the fact that $Y^A = \lambda$ must be reached for small values of A_S. Given that $\frac{\partial L^A}{\partial A_S}$ is defined over $\mathbb{R}_{++}$, by the implicit function theorem $L^A(A_S)$ is of class C^1. Thus if $h(A_S)$ changes sign over $[\bar{A_S}; \infty[$ then $L^A(A_S)$ has at least one turning point.

By (10), the relationship

$$G(\bar{A_S}S, A_L) = \hat{\lambda},$$

must hold. But from the definition of $g(A_S)$ above,

$$G(\bar{A_S}S, A_L) = \hat{\lambda} < \frac{\hat{\lambda}}{1-\sigma} = G(\bar{A_S}S, A_L\, g(\bar{A_S})),$$

$$\Rightarrow 1 < g(\bar{A_S}),$$

since G is increasing in L^A. Therefore,

$$h(\bar{A_S}) = L^A(\bar{A_S}) - g(\bar{A_S}) = 1 - g(\bar{A_S}) < 0.$$

Let us now study the value of h when $A_S \to \infty$.

Using (10),

$$\lim_{A_S \to \infty} L^A(A_S) = \nu^A + \nu^M \frac{\hat{\lambda}}{A_L \beta^{\frac{\sigma}{\sigma-1}}},$$

and using the definition of $g(A_S)$,

$$\lim_{A_S \to \infty} g(A_S) = \frac{\hat{\lambda}}{A_L \beta^{\frac{\sigma}{\sigma-1}}(1-\sigma)}.$$

Therefore,

$$\lim_{A_S \to \infty} h(A_S) = \nu^A + \frac{\hat{\lambda}}{A_L \beta^{\frac{\sigma}{\sigma-1}}}\left(\nu^M - \frac{1}{1-\sigma}\right).$$

Given $h(\bar{A_S}) < 0$, if $\lim_{A_S \to \infty} h(A_S) > 0$ then $h(A_S)$ must change sign. A sufficient condition for the existence of a turning point is therefore

$$\frac{\nu^A}{\nu^M} > \frac{\sigma}{(1-\sigma)(\hat{\lambda})^{-1} A_L \beta^{\frac{\sigma}{\sigma-1}} - 1}.$$

To prove that the turning point is unique, note that since $h(\bar{A_S}) < 0$, $L^A(A_S)$ must be increasing after the first turning point. Since $\frac{Y^A - \lambda}{Y^A} - \sigma$ is increasing in $L^A(A_S)$ and A_S, it can be treated as a one-variable function of A_S, increasing in A_S. Accordingly, $\frac{\partial L^A}{\partial \hat{S}}$ cannot change sign anymore and the turning point is unique.

<u>$\sigma > 1$ and $\lambda > 0$</u>

$L^A(A_L)$ is non-monotonic in this case. I use the same method as above.

$$\frac{\partial L^A}{\partial A_L} = \frac{\frac{\sigma - s_S}{s_S}\left(\frac{Y^A - \lambda}{Y^A} - \frac{\sigma(1-s_S)}{\sigma - s_S}\right)}{\frac{Y^A - \lambda}{Y^A}\frac{\hat{S}}{\hat{L^A}} + \gamma\left(\frac{\hat{S}}{\hat{L^A}}\right)^{\frac{1}{\sigma}}}.$$

Let $h(A_L) = L^A(A_L) - g(A_L)$, where $g(A_L)$ is the value of L^A implicitly defined by:

$$\frac{Y^A - \lambda}{Y^A} = \frac{\sigma(1-s_S)}{\sigma - s_S},$$

an immediate implication of the definition of h is

$$\begin{aligned} & h(A_L) \gtreqless 0, \\ \Leftrightarrow \quad & L^A(A_L) \gtreqless g(A_L), \\ \Leftrightarrow \quad & \frac{\sigma - s_S}{s_S}\left(\frac{Y^A - \lambda}{Y^A} - \frac{\sigma(1-s_S)}{\sigma - s_S}\right) \gtreqless 0 \quad \text{since } \frac{\sigma - s_S}{s_S}\left(\frac{Y^A - \lambda}{Y^A} - \frac{\sigma(1-s_S)}{\sigma - s_S}\right) \text{is increasing in } L^A, \\ \Leftrightarrow \quad & \frac{\partial L^A}{\partial A_L} \gtreqless 0, \end{aligned}$$

[9]

$h(A_L)$ and $\frac{\partial L^A}{\partial A_L}$ have the same sign.

Let us define $\bar{A_L}$ implicitly by $L^A(\bar{A_L}) = 1$. The existence of A_L was assumed explicitly by Proposition 1. Given that $\frac{\partial L^A}{\partial A_L}$ is defined over $\mathbb{R}_{++}$, by the implicit function theorem $L^A(A_L)$ is of class C^1. Thus if $h(A_L)$ changes sign over $[\bar{A_L}; \infty[$ then $L^A(A_L)$ has at least one turning point.

$$G(\hat{S}, \bar{A_L}) = \hat{\lambda} < \frac{\hat{\lambda}}{1 - \sigma\frac{1-s_S}{\sigma - s_S}} = G(\hat{S}, \bar{A_L}\, g(\bar{A_L})),$$

$$\Rightarrow 1 < g(\bar{A_L}),$$

since G is increasing in L^A. Therefore,

$$h(\bar{A_L}) = 1 - g(\bar{A_L}) < 0.$$

Let us now study the value of h when $A_L \to \infty$.

$$\lim_{A_L \to \infty} L^A(A_L) = \nu^A,$$

$$\lim_{A_L \to \infty} g(A_L) = 0, \quad \text{(using a proof by contradiction)}$$

$$\lim_{A_L \to \infty} h(A_L) = \nu^A > 0.$$

Thus $h(A_L)$ must change sign. Since $h(\bar{A_L}) < 0$, $L^A(A_L)$ must be increasing after the first turning point. Since $\frac{\sigma - s_S}{s_S}\left(\frac{Y^A-\lambda}{Y^A} - \frac{\sigma(1-s_S)}{\sigma - s_S}\right)$ is increasing in both $L^A(A_L)$ and A_L, it can be treated as a one-variable function of A_L, increasing in A_L. Accordingly, $\frac{\partial L^A}{\partial A_L}$ cannot change sign anymore and the turning point is unique.

A.3 Proof of Proposition 3

Proposition 3 involves straightforward first and second derivatives computations. They are given below.

Derivatives with respect to σ

$$X_1 = \frac{\frac{Y^A - \lambda}{Y^A}\frac{1}{s_S}}{\left(\frac{Y^A - \lambda}{Y^A} + \frac{\sigma}{\nu^M}\frac{1 - s_S}{s_S}\right)^2} > 0, \tag{38}$$

$$\frac{\partial \epsilon_{L^A, A_L}}{\partial \sigma} = X_1 \left(\frac{1 - s_S \nu^A}{\nu^M} - \frac{\lambda}{Y^A}\right) > 0, \tag{39}$$

$$\frac{\partial \epsilon_{L^A, A_S}}{\partial \sigma} = -X_1 \, \frac{1 - s_S \nu^A}{\nu^M} < 0, \tag{40}$$

$$\frac{\partial \epsilon_{L^A, A}}{\partial \sigma} = -X_1 \, \frac{\lambda}{Y^A} < 0, \tag{41}$$

[9] Proving that $X = \frac{\sigma - s_S}{s_S}\left(\frac{Y^A-\lambda}{Y^A} - \frac{\sigma(1-s_S)}{\sigma - s_S}\right)$ is increasing in L^A requires a somewhat tedious computation. I give here the partial derivative of X with respect to $x = \left(\frac{\hat{L^A}}{\hat{S}}\right)^{\frac{\sigma-1}{\sigma}}$, so that the adventurous reader can check his or her own result. Note that the derivative of X turns out to be simpler than the derivative of $\frac{Y^A-\lambda}{Y^A} - \frac{\sigma(1-s_S)}{\sigma - s_S}$.

$$\frac{\partial X}{\partial x} = \hat{\lambda}\frac{\sigma}{\sigma - 1}\frac{\beta^2}{1-\beta}\frac{x}{\hat{S}}(\beta x + (1-\beta))^{\frac{1-2\sigma}{\sigma - 1}} > 0, \qquad \frac{\partial x}{\partial L^A} > 0.$$

$$\frac{\partial X_1}{\partial \sigma} = -2X_1 \, \frac{\dfrac{1-s_S}{\nu^M\, s_S}}{\dfrac{Y^A-\lambda}{Y^A} + \dfrac{\sigma}{\nu^M}\dfrac{1-s_S}{s_S}} < 0. \tag{42}$$

Given (42), first and second derivatives are opposite in sign.

Derivatives with respect to Y^A

$$X_2 = \frac{\dfrac{\lambda}{{Y^A}^2}\dfrac{\sigma}{s_S}}{\left(\dfrac{Y^A-\lambda}{Y^A} + \dfrac{\sigma}{\nu^M}\dfrac{1-s_S}{s_S}\right)^2} > 0, \tag{43}$$

$$\frac{\partial \epsilon_{L^A,A_L}}{\partial Y^A} = X_2 \, \frac{1-s_S}{s_S} \, \frac{\sigma - s_S\,\nu^A}{\nu^M} \gtreqless 0 \quad \Leftrightarrow \quad \sigma \gtreqless s_S\,\nu^A, \tag{44}$$

$$\frac{\partial \epsilon_{L^A,A_S}}{\partial Y^A} = X_2 \, \frac{1-s_S\,\nu^A}{\nu^M} > 0, \tag{45}$$

$$\frac{\partial \epsilon_{L^A,A}}{\partial Y^A} = X_2 \left(1 + \frac{\sigma}{\nu^M}\frac{1-s_S}{s_S}\right) > 0, \tag{46}$$

$$\frac{\partial X_2}{\partial Y^A} = -2\,\frac{X_2}{Y^A} \, \frac{1 + \dfrac{\sigma}{\nu^M}\dfrac{1-s_S}{s_S}}{\dfrac{Y^A-\lambda}{Y^A} + \dfrac{\sigma}{\nu^M}\dfrac{1-s_S}{s_S}} < 0. \tag{47}$$

Given (47), first and second derivatives are opposite in sign.

B Main results under CES preferences

Let us assume that preferences take the following CES form:

$$U(C^A, C^M) = \left[\nu^A\,(C^A-\lambda)^{\frac{\epsilon-1}{\epsilon}} + \nu^M\,(C^M)^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}, \qquad \nu^A + \nu^M = 1,\ \epsilon > 0, \tag{48}$$

then the following proposition is the equivalent of Proposition 1.

Proposition 4 *Consider a competitive market economy whose technology is characterized by* (1) *and* (2)*, whose representative consumer has preferences* (48) *and with market clearing* (5)*.*

Then, at an interior solution, the equilibrium allocation of labor L^A reacts to exogenous parameters as following:

$$\frac{\partial L^A}{\partial \nu^A} > 0 \qquad \frac{\partial L^A}{\partial \lambda} > 0,$$

$$\frac{\partial L^A}{\partial A} \lesseqgtr 0 \Leftrightarrow \frac{\epsilon - 1}{\epsilon} Y^A \lesseqgtr \lambda \qquad \frac{\partial L^A}{\partial M} \lesseqgtr 0 \Leftrightarrow \epsilon \gtreqless 1,$$

$$\frac{\partial L^A}{\partial A_L} \lesseqgtr 0 \Leftrightarrow \frac{Y^A - \lambda}{Y^A} \frac{\sigma - s_S}{1 - s_S} \lesseqgtr \frac{\sigma}{\epsilon},$$

$$\frac{\partial L^A}{\partial A_S} \lesseqgtr 0 \Leftrightarrow \frac{Y^A - \lambda}{Y^A} \lesseqgtr \frac{\sigma}{\epsilon},$$

furthermore, $\frac{\partial L^A}{\partial S}$ *has the same sign as* $\frac{\partial L^A}{\partial A_S}$.

By examining the sign conditions of $\frac{\partial L^A}{\partial A_L}$ and $\frac{\partial L^A}{\partial A_S}$, it is apparent that CES preferences extend the initial results in a straightforward manner: the threshold σ under Cobb-Douglas preferences is now replaced by the threshold $\frac{\sigma}{\epsilon}$. It is possible as in Proposition 1 to draw the consequences of different values of σ and ϵ by choosing for them a value less, equal or greater than one (with now nine different cases). A low ϵ increases the threshold of effectiveness for A_L and A_S; intuitively, low substitution possibilities between goods means that technical change is effective *further away* from the state of subsistence. Another consequence of CES preferences is that Hicks-neutral technical change (both in agriculture and manufacturing) is now subject to conditions on ϵ. When $\epsilon < 1$, A drives labor out of agriculture while M drives labor in agriculture. When $\epsilon > 1$, A drives labor out of agriculture provided agricultural output Y^A is lower than a fraction $\frac{\epsilon}{\epsilon-1}$ of the subsistence level λ, and M drives labor out of agriculture. Thus, the idea of proximity to subsistence is now extended to Hicks-neutral technical change. Besides, note that by introducing a positive endowment of manufacturing goods (say domestic production) into the utility function $U(C^A - \lambda, C^M + \mu)$, as in Alvarez-Cuadrado and Poschke (2011), M drives labor out of agriculture when $\epsilon < 1$ provided manufacturing production Y^M is lower than a fraction $\frac{\epsilon}{1-\epsilon}$ of the domestic production μ.

Proof of Proposition 4

This proof is entirely analogous to the proof of Proposition 1 in section A.1. I give the derivatives of the functions f and g, which are defined in the same manner as in section A.1.

$$f(L^A, \nu^A, M) = \frac{\nu^A}{\nu^M} \frac{[MF(L^M)]^{\frac{1}{\epsilon}}}{MF'(L^M)}, \tag{49}$$

$$g(\hat{S}, \hat{L^A}, \lambda, A) = \frac{[AG(\hat{L^A}, \hat{S}) - \lambda]^{\frac{1}{\epsilon}}}{AG_{\hat{L^A}}(\hat{L^A}, \hat{S})}. \tag{50}$$

$$f_{L^A} = \frac{\nu^A}{\nu^M}\, [MF]^{\frac{1}{\epsilon}-1} \left(\frac{FF''}{(F')^2} - \frac{1}{\epsilon} \right) < 0,$$

$$f_M = \frac{\nu^A}{\nu^M}\, [MF]^{\frac{1}{\epsilon}-1}\, \frac{\frac{1-\epsilon}{\epsilon} F}{MF'}\,,$$

$$f_{\nu^A} = \frac{1}{(\nu^M)^2}\, \frac{[MF]^{\frac{1}{\epsilon}}}{MF'} > 0,$$

$$g_{\hat{L^A}} = [AG-\lambda]^{\frac{1}{\epsilon}-1} \left(\frac{1}{\epsilon} + \frac{(G-\frac{\lambda}{A})(-G_{\hat{L^A}^2})}{(G_{\hat{L^A}})^2} \right) > 0, \tag{51}$$

$$g_{\hat{S}} = [AG-\lambda]^{\frac{1}{\epsilon}-1}\, \frac{\frac{1}{\epsilon} G_{\hat{S}} G_{\hat{L^A}} - (G-\frac{\lambda}{A}) G_{\hat{S}\hat{L^A}}}{(G_{\hat{L^A}})^2} \geq 0 \text{ or } < 0,$$

$$g_A = [AG-\lambda]^{\frac{1}{\epsilon}-1}\, \frac{\frac{1-\epsilon}{\epsilon} G + \frac{\lambda}{A}}{AG_{\hat{L^A}}} < 0,$$

$$g_{\hat{\lambda}} = -\frac{1}{\epsilon}\, \frac{[AG-\lambda]^{\frac{1}{\epsilon}-1}}{AG_{\hat{L^A}}} < 0.$$

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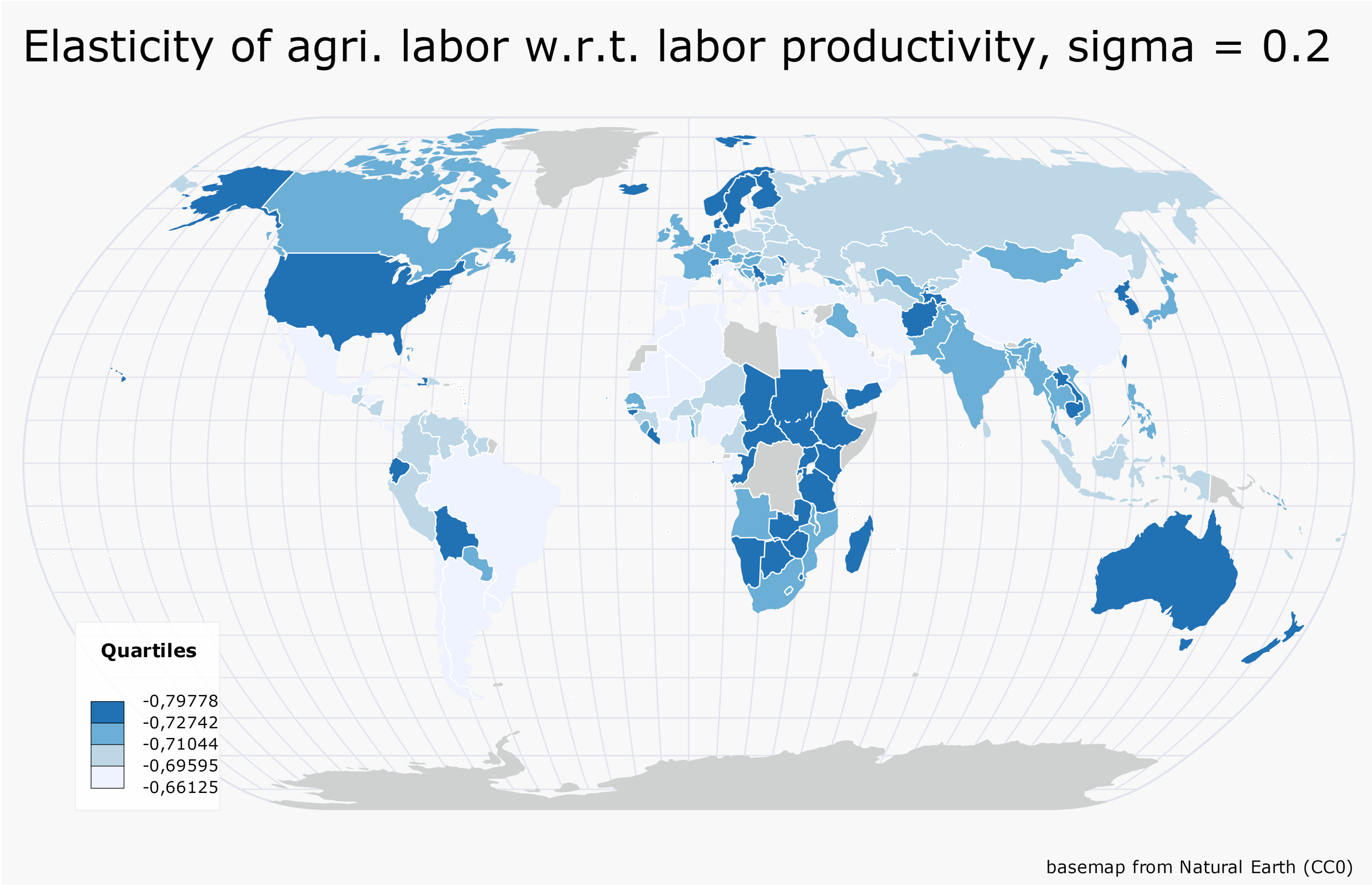
Figure 5


Elasticity of agri. labor w.r.t. labor productivity, sigma = 0.2
Quartiles
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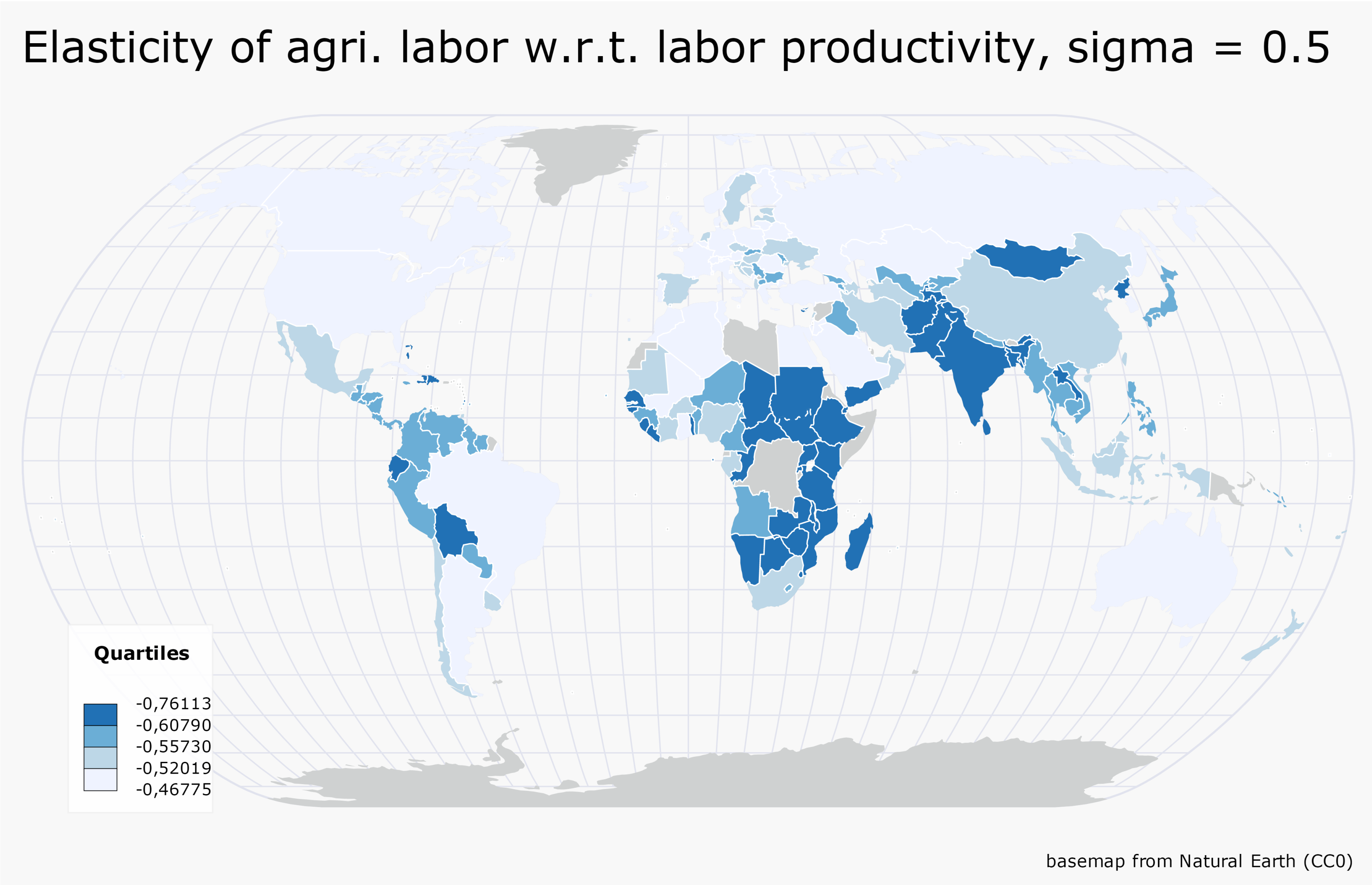
-0,66125
basemap from Natural Earth (CC0)

Figure 6



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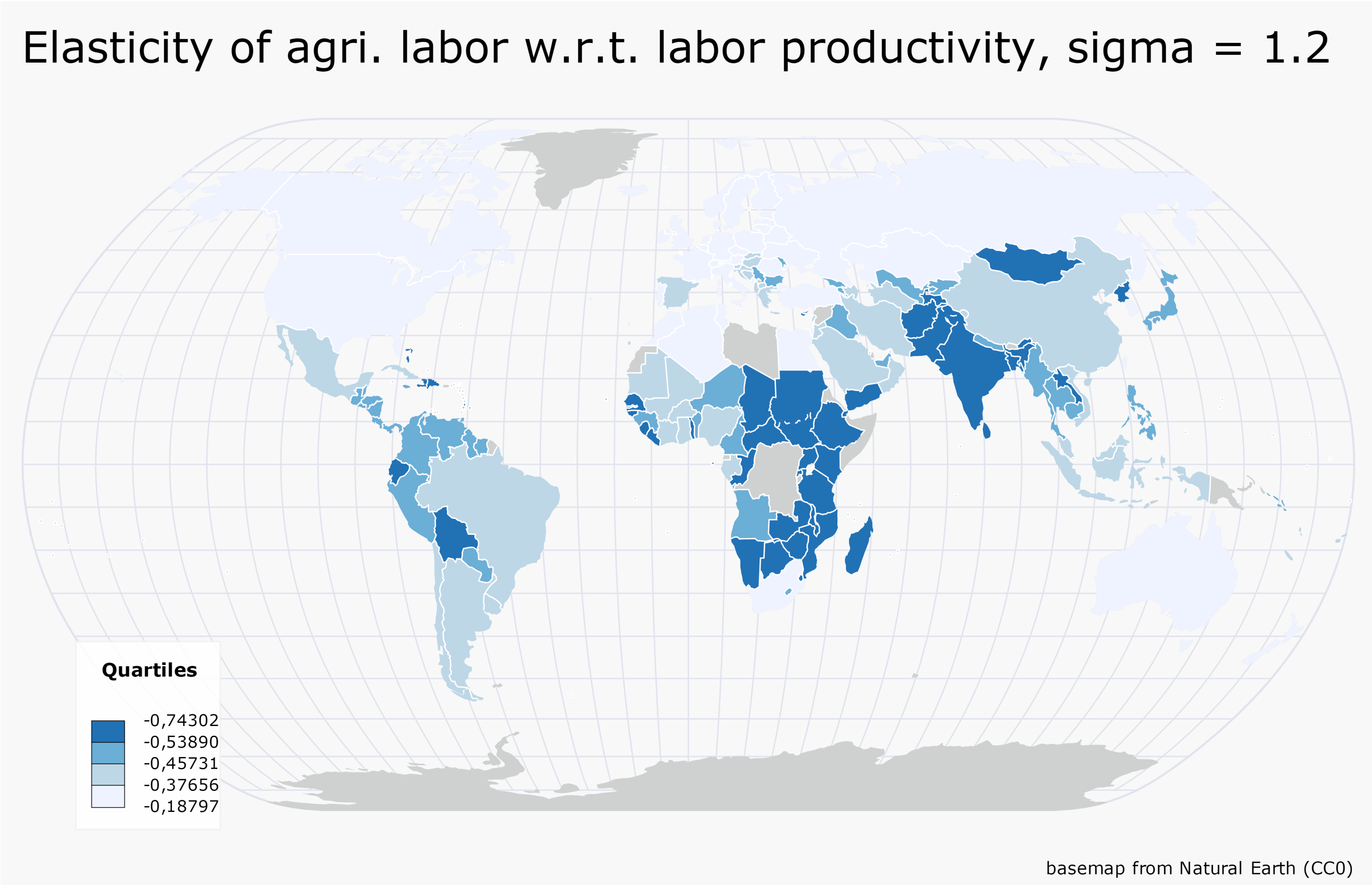
-0,46775
basemap from Natural Earth (CC0)

Figure 7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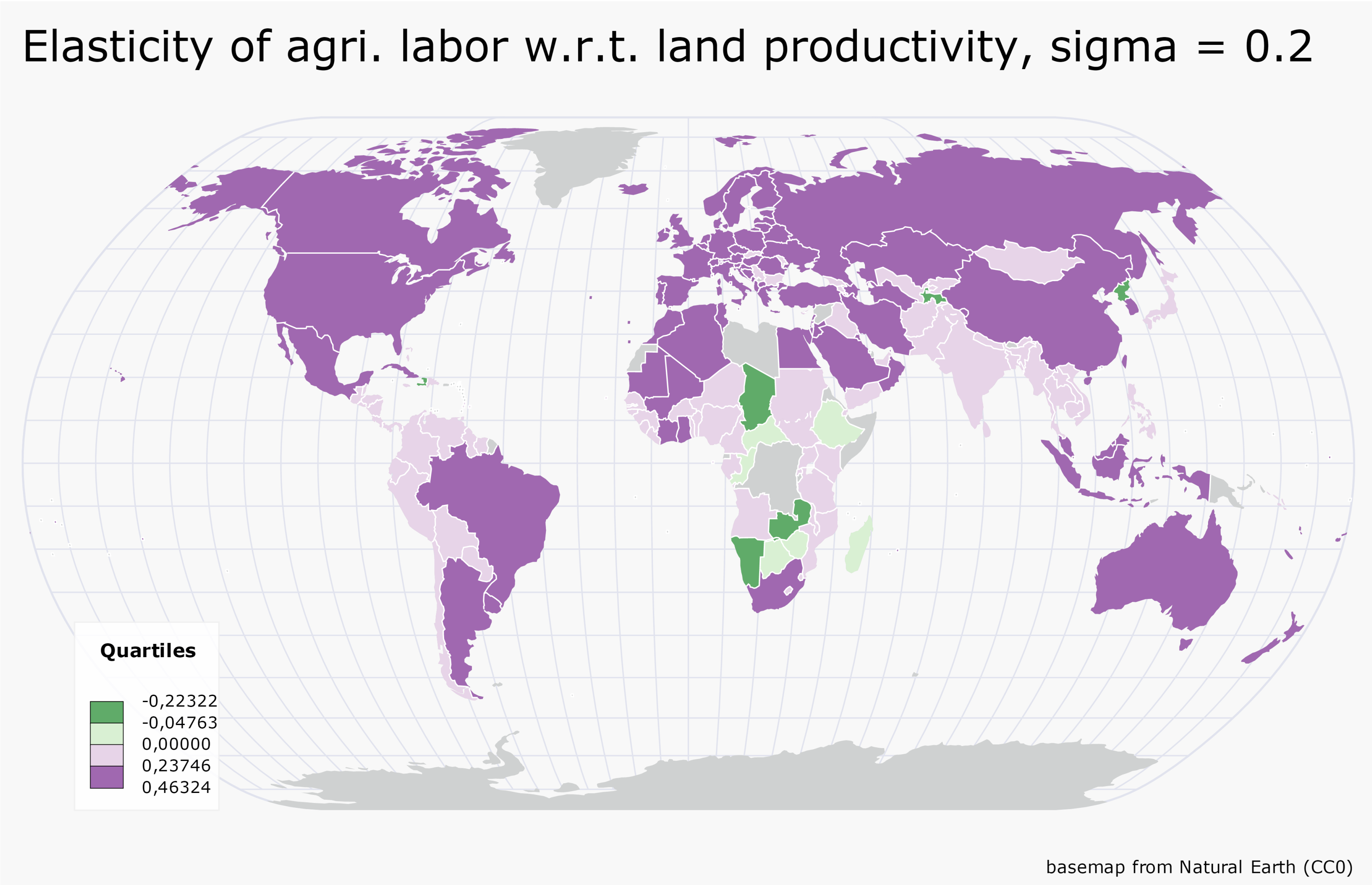
basemap from Natural Earth (CC0)

Figure 8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basemap from Natural Earth (CC0)

Figure 9

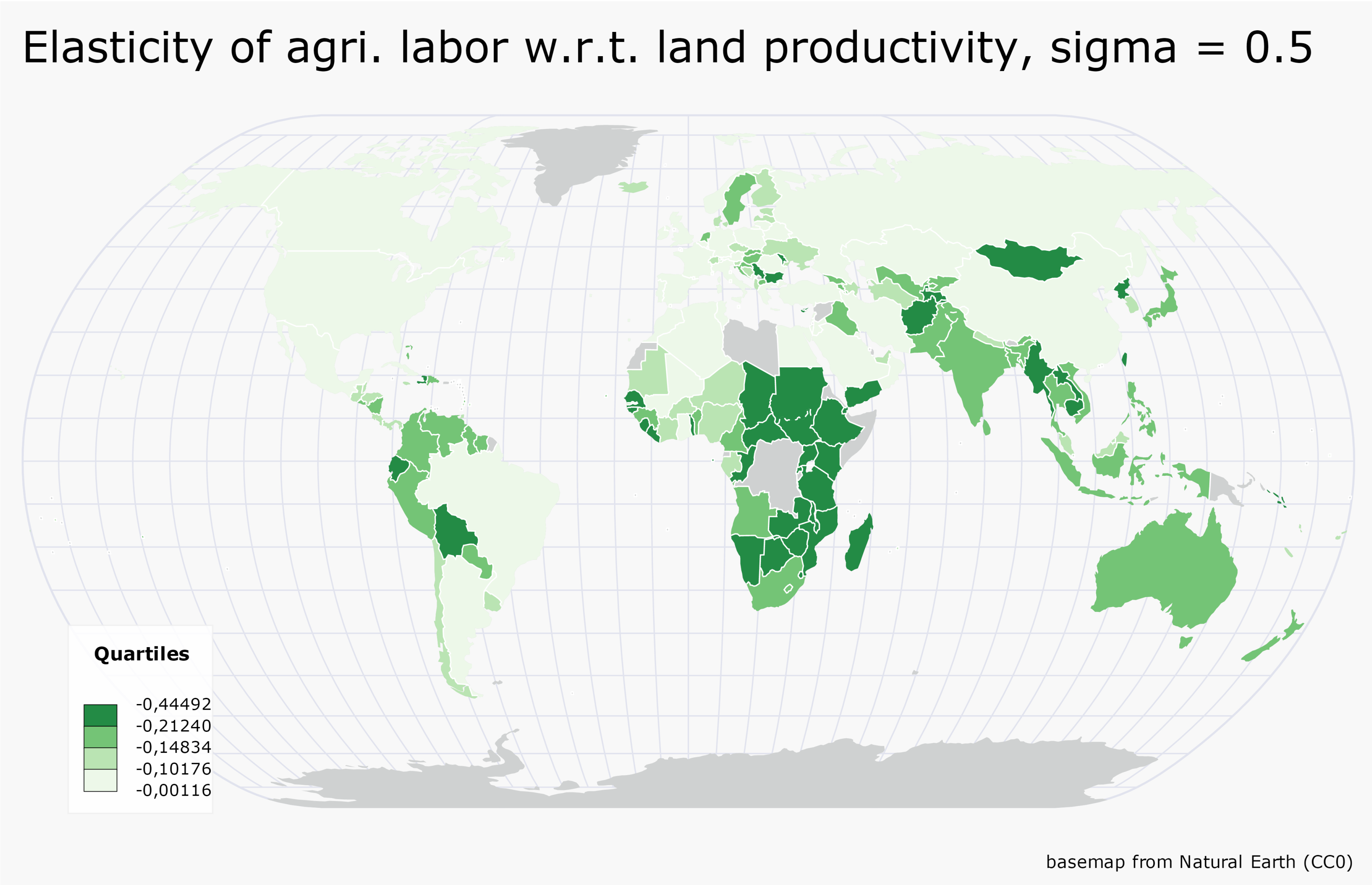
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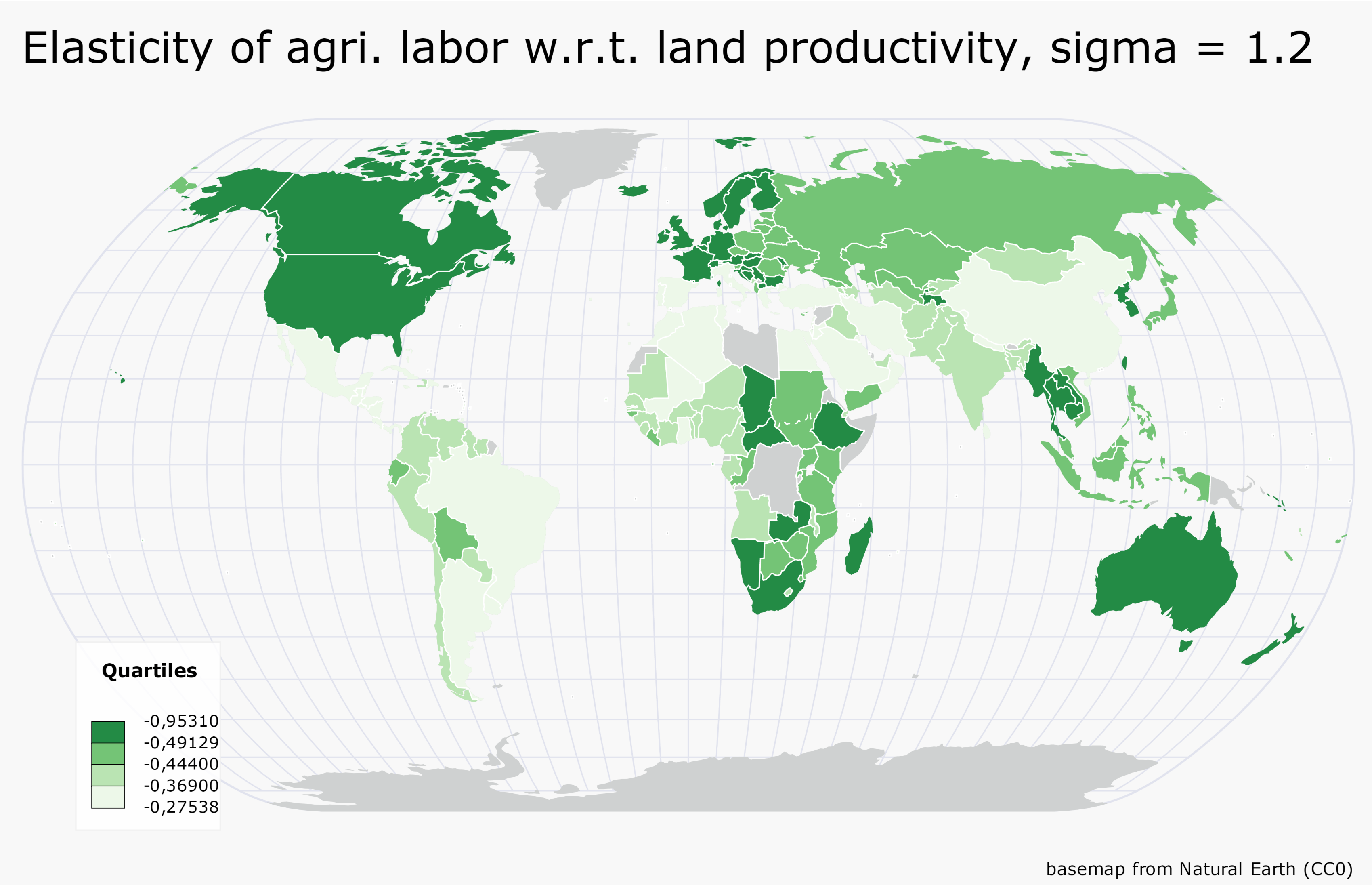
Figure 10


Elasticity of agri. labor w.r.t. land productivity, sigma = 1.2
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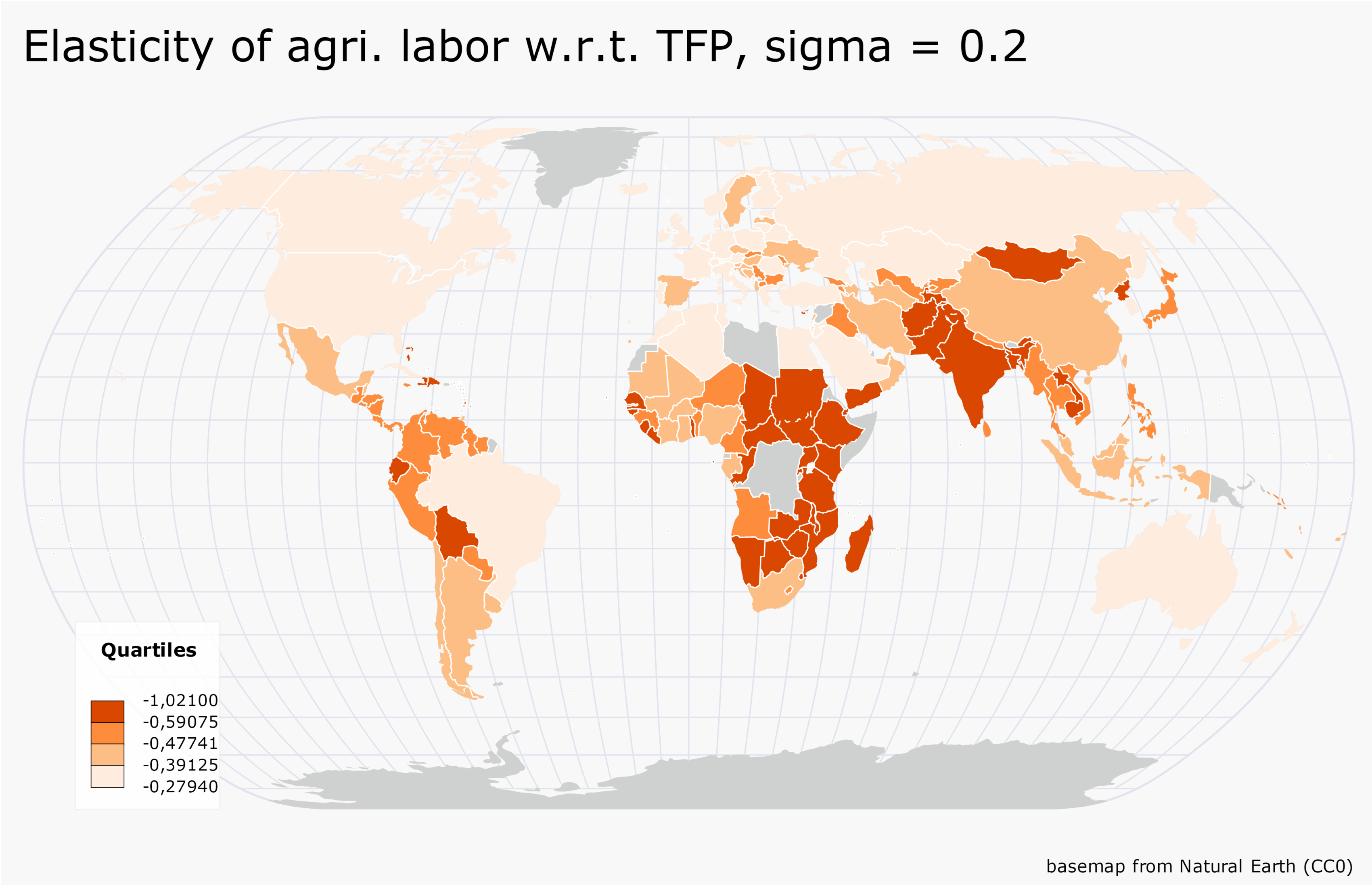
basemap from Natural Earth (CC0)

Figure 11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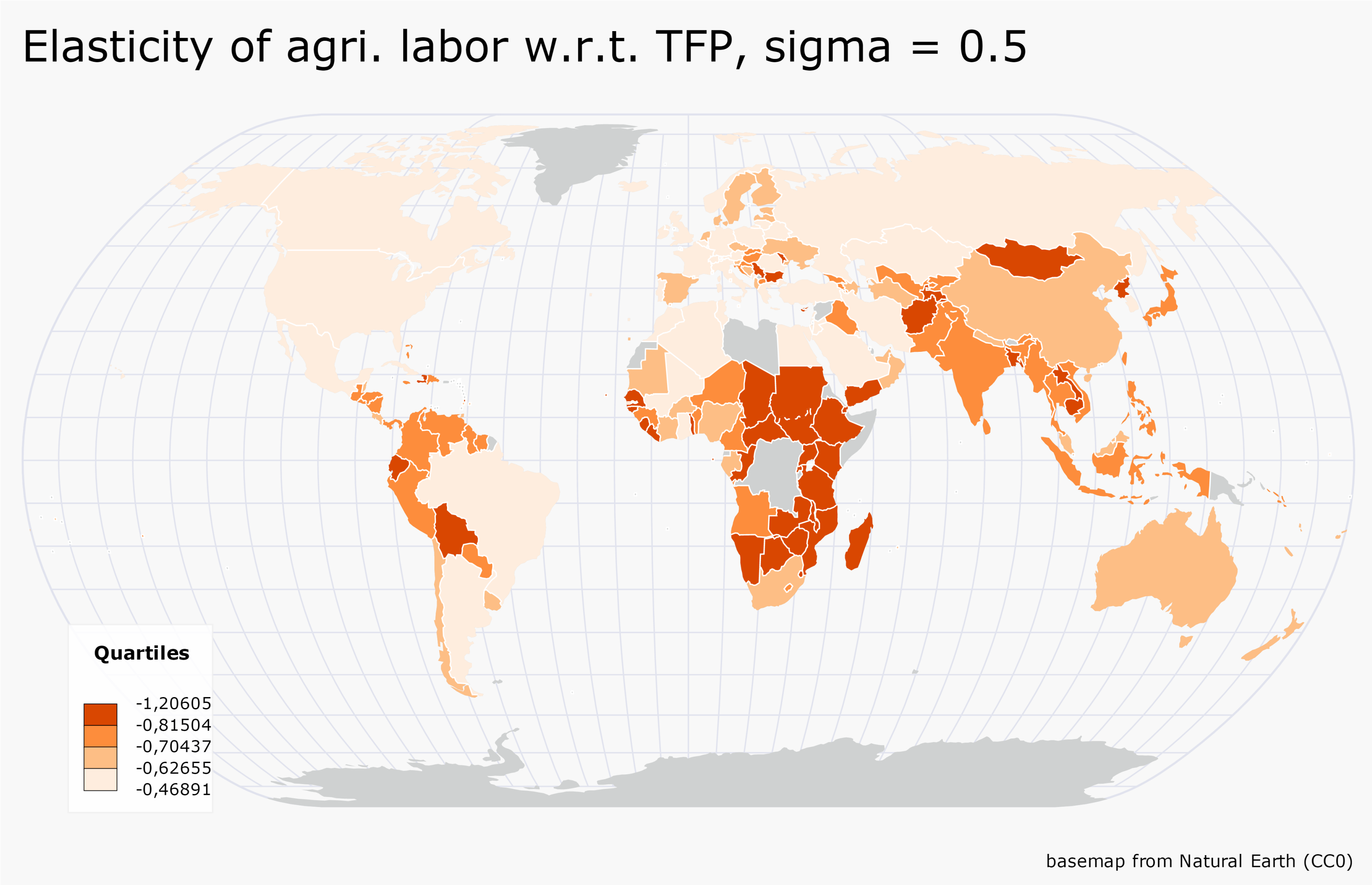
basemap from Natural Earth (CC0)

Figure 12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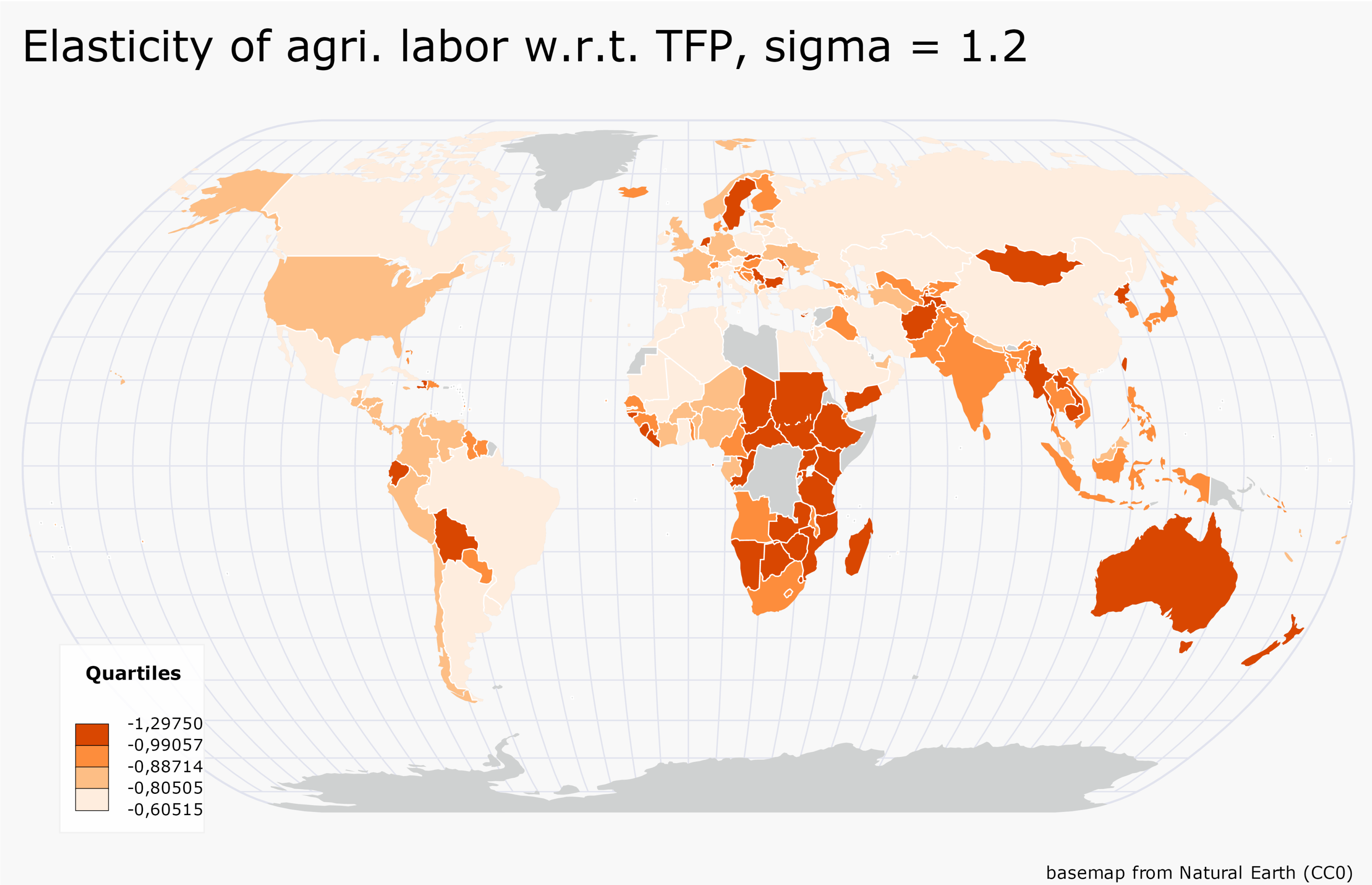
basemap from Natural Earth (CC0)

Figure 13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Quartiles
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-0,80505
-0,60515
basemap from Natural Earth (CC0)

A Closer Look at the Mechanism of Structural Transformation: the Role of Land- versus Labor-Augmenting Technical Change

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September 14, 2018

C Country results

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Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
Central Asia						
Armenia	0.33	0.45	0.2	-0.71	0.21	-0.50
			0.5	-0.57	-0.17	-0.74
			1.2	-0.47	-0.44	-0.91
Azerbaijan	0.38	0.45	0.2	-0.70	0.27	-0.43
			0.5	-0.54	-0.12	-0.65
			1.2	-0.42	-0.41	-0.82
Georgia	0.31	0.45	0.2	-0.71	0.19	-0.52
			0.5	-0.58	-0.19	-0.77
			1.2	-0.48	-0.45	-0.94
Kazakhstan	0.42	0.51	0.2	-0.70	0.34	-0.36
			0.5	-0.51	-0.09	-0.60
			1.2	-0.34	-0.46	-0.80
Kyrgyzstan	0.33	0.45	0.2	-0.71	0.22	-0.49
			0.5	-0.57	-0.17	-0.73
			1.2	-0.46	-0.44	-0.90
Russian Federation	0.42	0.51	0.2	-0.70	0.35	-0.36
			0.5	-0.51	-0.08	-0.59
			1.2	-0.34	-0.46	-0.80
Tajikistan	0.14	0.45	0.2	-0.78	-0.15	-0.93
			0.5	-0.72	-0.44	-1.17
			1.2	-0.70	-0.60	-1.29
Turkey	0.50	0.41	0.2	-0.66	0.37	-0.30
			0.5	-0.47	0.00	-0.47
			1.2	-0.31	-0.29	-0.61
Turkmenistan	0.35	0.45	0.2	-0.70	0.24	-0.46
			0.5	-0.55	-0.14	-0.69
			1.2	-0.44	-0.43	-0.87
Uzbekistan	0.31	0.45	0.2	-0.71	0.19	-0.52
			0.5	-0.58	-0.19	-0.76
			1.2	-0.48	-0.45	-0.93
East Asia & Pacific						
Australia	0.40	0.69	0.2	-0.75	0.40	-0.35
			0.5	-0.51	-0.15	-0.66
			1.2	-0.24	-0.78	-1.03
Brunei Darussalam	0.37	0.47	0.2	-0.71	0.27	-0.44
			0.5	-0.54	-0.14	-0.68
			1.2	-0.42	-0.45	-0.86
Cambodia	0.27	0.47	0.2	-0.73	0.14	-0.59
			0.5	-0.61	-0.26	-0.86
			1.2	-0.52	-0.53	-1.05

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
China	0.38	0.40	0.2	-0.68	0.25	-0.43
			0.5	-0.54	-0.10	-0.64
			1.2	-0.43	-0.34	-0.78
China, Taiwan Province of	0.35	0.71	0.2	-0.75	0.34	-0.42
			0.5	-0.53	-0.26	-0.80
			1.2	-0.28	-0.95	-1.23
DPR Korea	0.11	0.40	0.2	-0.79	-0.20	-1.00
			0.5	-0.76	-0.41	-1.17
			1.2	-0.74	-0.52	-1.26
Fiji	0.36	0.47	0.2	-0.71	0.27	-0.44
			0.5	-0.54	-0.14	-0.68
			1.2	-0.42	-0.45	-0.87
French Polynesia	0.35	0.47	0.2	-0.71	0.25	-0.46
			0.5	-0.55	-0.16	-0.71
			1.2	-0.44	-0.46	-0.90
Indonesia	0.34	0.47	0.2	-0.71	0.24	-0.47
			0.5	-0.56	-0.16	-0.72
			1.2	-0.44	-0.46	-0.90
Japan	0.31	0.47	0.2	-0.72	0.19	-0.52
			0.5	-0.58	-0.20	-0.78
			1.2	-0.48	-0.48	-0.96
Kiribati	0.43	0.47	0.2	-0.69	0.34	-0.35
			0.5	-0.50	-0.07	-0.57
			1.2	-0.35	-0.40	-0.75
Lao PDR	0.24	0.47	0.2	-0.74	0.08	-0.66
			0.5	-0.63	-0.30	-0.93
			1.2	-0.56	-0.55	-1.11
Malaysia	0.36	0.47	0.2	-0.71	0.26	-0.44
			0.5	-0.54	-0.14	-0.68
			1.2	-0.42	-0.45	-0.87
Mongolia	0.25	0.40	0.2	-0.72	0.09	-0.64
			0.5	-0.63	-0.23	-0.86
			1.2	-0.57	-0.42	-0.99
Myanmar	0.30	0.47	0.2	-0.72	0.18	-0.55
			0.5	-0.59	-0.22	-0.81
			1.2	-0.49	-0.50	-1.00
New Caledonia	0.36	0.47	0.2	-0.71	0.26	-0.44
			0.5	-0.54	-0.14	-0.69
			1.2	-0.42	-0.45	-0.87

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
New Zealand	0.38	0.69	0.2	-0.75	0.38	-0.37
			0.5	-0.52	-0.18	-0.70
			1.2	-0.26	-0.82	-1.08
Philippines	0.32	0.47	0.2	-0.72	0.21	-0.51
			0.5	-0.57	-0.19	-0.76
			1.2	-0.47	-0.48	-0.95
Republic of Korea	0.43	0.71	0.2	-0.75	0.44	-0.31
			0.5	-0.50	-0.11	-0.61
			1.2	-0.20	-0.79	-0.99
Samoa	0.38	0.47	0.2	-0.70	0.29	-0.41
			0.5	-0.53	-0.12	-0.65
			1.2	-0.40	-0.43	-0.83
Solomon Islands	0.30	0.47	0.2	-0.72	0.19	-0.53
			0.5	-0.58	-0.21	-0.80
			1.2	-0.48	-0.50	-0.98
Thailand	0.31	0.47	0.2	-0.72	0.20	-0.52
			0.5	-0.58	-0.20	-0.78
			1.2	-0.47	-0.49	-0.97
Vanuatu	0.39	0.47	0.2	-0.70	0.30	-0.40
			0.5	-0.53	-0.11	-0.63
			1.2	-0.39	-0.43	-0.82
Vietnam	0.33	0.47	0.2	-0.71	0.23	-0.48
			0.5	-0.56	-0.17	-0.73
			1.2	-0.45	-0.47	-0.92
Europe						
Albania	0.38	0.51	0.2	-0.71	0.31	-0.40
			0.5	-0.53	-0.13	-0.65
			1.2	-0.38	-0.49	-0.86
Austria	0.47	0.61	0.2	-0.72	0.44	-0.28
			0.5	-0.49	-0.03	-0.52
			1.2	-0.23	-0.55	-0.78
Belarus	0.43	0.51	0.2	-0.70	0.36	-0.34
			0.5	-0.50	-0.07	-0.57
			1.2	-0.33	-0.45	-0.78
Belgium	0.47	0.61	0.2	-0.72	0.44	-0.28
			0.5	-0.49	-0.04	-0.53
			1.2	-0.24	-0.56	-0.79
Bosnia and Herzegovina	0.37	0.51	0.2	-0.71	0.29	-0.43
			0.5	-0.54	-0.15	-0.69
			1.2	-0.40	-0.50	-0.90

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
Bulgaria	0.30	0.51	0.2	-0.73	0.19	-0.53
			0.5	-0.58	-0.24	-0.82
			1.2	-0.47	-0.57	-1.03
Croatia	0.35	0.51	0.2	-0.72	0.27	-0.45
			0.5	-0.55	-0.16	-0.71
			1.2	-0.41	-0.51	-0.92
Cyprus	0.26	0.42	0.2	-0.72	0.10	-0.62
			0.5	-0.62	-0.24	-0.86
			1.2	-0.55	-0.45	-1.00
Czechia	0.39	0.51	0.2	-0.71	0.32	-0.39
			0.5	-0.52	-0.12	-0.64
			1.2	-0.37	-0.48	-0.85
Denmark	0.41	0.61	0.2	-0.73	0.38	-0.35
			0.5	-0.51	-0.12	-0.63
			1.2	-0.29	-0.63	-0.92
Estonia	0.39	0.51	0.2	-0.71	0.32	-0.39
			0.5	-0.52	-0.11	-0.64
			1.2	-0.37	-0.48	-0.85
Finland	0.40	0.61	0.2	-0.73	0.37	-0.36
			0.5	-0.52	-0.13	-0.64
			1.2	-0.30	-0.64	-0.93
France	0.44	0.61	0.2	-0.73	0.42	-0.31
			0.5	-0.50	-0.07	-0.57
			1.2	-0.26	-0.59	-0.84
Germany	0.44	0.61	0.2	-0.73	0.41	-0.32
			0.5	-0.50	-0.08	-0.58
			1.2	-0.26	-0.59	-0.86
Greece	0.43	0.42	0.2	-0.68	0.31	-0.37
			0.5	-0.51	-0.06	-0.57
			1.2	-0.38	-0.34	-0.72
Hungary	0.35	0.51	0.2	-0.72	0.27	-0.45
			0.5	-0.55	-0.17	-0.71
			1.2	-0.41	-0.52	-0.93
Iceland	0.42	0.61	0.2	-0.73	0.39	-0.34
			0.5	-0.51	-0.11	-0.62
			1.2	-0.28	-0.62	-0.90
Ireland	0.46	0.61	0.2	-0.72	0.44	-0.29
			0.5	-0.49	-0.04	-0.54
			1.2	-0.24	-0.56	-0.80
Italy	0.45	0.42	0.2	-0.67	0.33	-0.34
			0.5	-0.49	-0.04	-0.53
			1.2	-0.35	-0.33	-0.68

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
Latvia	0.39	0.51	0.2	-0.71	0.31	-0.40
			0.5	-0.53	-0.12	-0.65
			1.2	-0.38	-0.49	-0.86
Lithuania	0.43	0.51	0.2	-0.70	0.36	-0.34
			0.5	-0.50	-0.07	-0.57
			1.2	-0.33	-0.44	-0.77
Luxembourg	0.44	0.61	0.2	-0.73	0.41	-0.32
			0.5	-0.50	-0.08	-0.58
			1.2	-0.26	-0.59	-0.86
Malta	0.42	0.42	0.2	-0.68	0.30	-0.38
			0.5	-0.51	-0.07	-0.58
			1.2	-0.39	-0.35	-0.73
Montenegro	0.44	0.51	0.2	-0.70	0.36	-0.34
			0.5	-0.50	-0.07	-0.57
			1.2	-0.33	-0.44	-0.77
Netherlands	0.38	0.61	0.2	-0.73	0.34	-0.39
			0.5	-0.53	-0.17	-0.69
			1.2	-0.32	-0.67	-0.99
Norway	0.43	0.61	0.2	-0.73	0.41	-0.32
			0.5	-0.50	-0.08	-0.59
			1.2	-0.27	-0.60	-0.86
Poland	0.43	0.51	0.2	-0.70	0.36	-0.35
			0.5	-0.50	-0.07	-0.58
			1.2	-0.33	-0.45	-0.78
Portugal	0.44	0.42	0.2	-0.68	0.32	-0.35
			0.5	-0.50	-0.05	-0.55
			1.2	-0.36	-0.33	-0.70
Republic of Moldova	0.28	0.51	0.2	-0.73	0.15	-0.58
			0.5	-0.60	-0.28	-0.87
			1.2	-0.50	-0.59	-1.09
Romania	0.42	0.51	0.2	-0.70	0.34	-0.36
			0.5	-0.51	-0.08	-0.60
			1.2	-0.34	-0.46	-0.80
Serbia	0.29	0.51	0.2	-0.73	0.18	-0.55
			0.5	-0.59	-0.25	-0.84
			1.2	-0.48	-0.58	-1.06
Slovakia	0.32	0.51	0.2	-0.72	0.22	-0.50
			0.5	-0.57	-0.21	-0.78
			1.2	-0.45	-0.55	-0.99
Slovenia	0.38	0.51	0.2	-0.71	0.31	-0.40
			0.5	-0.53	-0.13	-0.66
			1.2	-0.38	-0.49	-0.87

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
Spain	0.39	0.42	0.2	-0.69	0.27	-0.42
			0.5	-0.53	-0.10	-0.63
			1.2	-0.42	-0.37	-0.78
Sweden	0.38	0.61	0.2	-0.73	0.34	-0.39
			0.5	-0.53	-0.17	-0.70
			1.2	-0.32	-0.67	-1.00
Switzerland	0.42	0.61	0.2	-0.73	0.39	-0.34
			0.5	-0.51	-0.10	-0.61
			1.2	-0.28	-0.61	-0.89
FYR Macedonia	0.33	0.51	0.2	-0.72	0.24	-0.48
			0.5	-0.56	-0.19	-0.75
			1.2	-0.43	-0.53	-0.97
Ukraine	0.39	0.51	0.2	-0.71	0.31	-0.40
			0.5	-0.53	-0.12	-0.65
			1.2	-0.37	-0.48	-0.86
United Kingdom	0.43	0.60	0.2	-0.72	0.40	-0.33
			0.5	-0.50	-0.08	-0.59
			1.2	-0.28	-0.58	-0.86
Latin America & Caribbean						
Argentina	0.41	0.41	0.2	-0.68	0.28	-0.40
			0.5	-0.52	-0.08	-0.60
			1.2	-0.40	-0.34	-0.75
Bahamas	0.27	0.36	0.2	-0.71	0.10	-0.61
			0.5	-0.62	-0.18	-0.81
			1.2	-0.57	-0.35	-0.92
Barbados	0.34	0.36	0.2	-0.69	0.19	-0.50
			0.5	-0.57	-0.12	-0.69
			1.2	-0.49	-0.32	-0.81
Belize	0.36	0.36	0.2	-0.68	0.21	-0.48
			0.5	-0.56	-0.11	-0.66
			1.2	-0.48	-0.31	-0.78
Bolivia	0.21	0.41	0.2	-0.74	0.01	-0.73
			0.5	-0.66	-0.29	-0.96
			1.2	-0.62	-0.47	-1.09
Brazil	0.42	0.41	0.2	-0.68	0.29	-0.38
			0.5	-0.51	-0.07	-0.58
			1.2	-0.39	-0.34	-0.73
Chile	0.36	0.41	0.2	-0.69	0.23	-0.46
			0.5	-0.55	-0.12	-0.67
			1.2	-0.45	-0.37	-0.82

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
Colombia	0.33	0.41	0.2	-0.70	0.20	-0.51
			0.5	-0.57	-0.16	-0.73
			1.2	-0.48	-0.39	-0.88
Costa Rica	0.34	0.36	0.2	-0.69	0.19	-0.50
			0.5	-0.57	-0.12	-0.69
			1.2	-0.49	-0.32	-0.81
Cuba	0.42	0.36	0.2	-0.66	0.27	-0.39
			0.5	-0.51	-0.05	-0.56
			1.2	-0.41	-0.28	-0.68
Dominican Republic	0.28	0.36	0.2	-0.71	0.11	-0.60
			0.5	-0.61	-0.18	-0.79
			1.2	-0.56	-0.35	-0.90
Ecuador	0.24	0.41	0.2	-0.73	0.07	-0.66
			0.5	-0.64	-0.25	-0.89
			1.2	-0.58	-0.45	-1.03
El Salvador	0.30	0.36	0.2	-0.70	0.14	-0.56
			0.5	-0.60	-0.16	-0.75
			1.2	-0.53	-0.33	-0.87
Guatemala	0.31	0.36	0.2	-0.70	0.15	-0.54
			0.5	-0.59	-0.15	-0.74
			1.2	-0.52	-0.33	-0.85
Guyana	0.31	0.41	0.2	-0.71	0.18	-0.53
			0.5	-0.58	-0.17	-0.75
			1.2	-0.50	-0.40	-0.90
Haiti	0.13	0.36	0.2	-0.78	-0.14	-0.92
			0.5	-0.75	-0.33	-1.08
			1.2	-0.73	-0.43	-1.15
Honduras	0.32	0.36	0.2	-0.69	0.17	-0.52
			0.5	-0.58	-0.14	-0.72
			1.2	-0.51	-0.32	-0.83
Jamaica	0.31	0.36	0.2	-0.70	0.16	-0.54
			0.5	-0.59	-0.14	-0.73
			1.2	-0.52	-0.33	-0.85
Mexico	0.39	0.36	0.2	-0.67	0.24	-0.43
			0.5	-0.53	-0.08	-0.61
			1.2	-0.44	-0.29	-0.73
Nicaragua	0.29	0.36	0.2	-0.70	0.14	-0.57
			0.5	-0.60	-0.16	-0.76
			1.2	-0.54	-0.34	-0.88
Panama	0.33	0.36	0.2	-0.69	0.18	-0.52
			0.5	-0.58	-0.13	-0.71
			1.2	-0.50	-0.32	-0.83

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
Paraguay	0.29	0.41	0.2	-0.71	0.15	-0.56
			0.5	-0.60	-0.19	-0.79
			1.2	-0.52	-0.41	-0.94
Peru	0.32	0.41	0.2	-0.70	0.19	-0.51
			0.5	-0.57	-0.16	-0.73
			1.2	-0.49	-0.39	-0.88
Saint Lucia	0.26	0.36	0.2	-0.71	0.09	-0.62
			0.5	-0.63	-0.19	-0.82
			1.2	-0.57	-0.35	-0.93
St Vincent and the G.	0.35	0.36	0.2	-0.68	0.20	-0.48
			0.5	-0.56	-0.11	-0.67
			1.2	-0.48	-0.31	-0.79
Suriname	0.32	0.41	0.2	-0.71	0.18	-0.52
			0.5	-0.58	-0.17	-0.74
			1.2	-0.50	-0.40	-0.89
Trinidad and Tobago	0.36	0.36	0.2	-0.68	0.21	-0.47
			0.5	-0.55	-0.11	-0.66
			1.2	-0.47	-0.31	-0.78
Uruguay	0.38	0.41	0.2	-0.69	0.25	-0.44
			0.5	-0.54	-0.11	-0.64
			1.2	-0.43	-0.36	-0.79
Venezuela	0.33	0.41	0.2	-0.70	0.20	-0.50
			0.5	-0.57	-0.15	-0.72
			1.2	-0.48	-0.39	-0.87
Middle East & North Africa						
Algeria	0.44	0.41	0.2	-0.67	0.32	-0.36
			0.5	-0.50	-0.05	-0.55
			1.2	-0.37	-0.33	-0.69
Djibouti	0.26	0.42	0.2	-0.72	0.11	-0.61
			0.5	-0.62	-0.23	-0.84
			1.2	-0.55	-0.44	-0.99
Egypt	0.48	0.41	0.2	-0.67	0.35	-0.31
			0.5	-0.48	-0.01	-0.49
			1.2	-0.33	-0.30	-0.63
Iran	0.39	0.41	0.2	-0.69	0.27	-0.42
			0.5	-0.53	-0.09	-0.63
			1.2	-0.42	-0.35	-0.77
Iraq	0.29	0.41	0.2	-0.71	0.15	-0.56
			0.5	-0.60	-0.19	-0.79
			1.2	-0.52	-0.41	-0.94

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
Israel	0.49	0.41	0.2	-0.66	0.36	-0.30
			0.5	-0.47	0.00	-0.47
			1.2	-0.32	-0.29	-0.61
Jordan	0.42	0.41	0.2	-0.68	0.30	-0.38
			0.5	-0.51	-0.07	-0.58
			1.2	-0.39	-0.34	-0.73
Kuwait	0.45	0.41	0.2	-0.67	0.33	-0.35
			0.5	-0.49	-0.04	-0.53
			1.2	-0.36	-0.32	-0.68
Lebanon	0.39	0.41	0.2	-0.69	0.27	-0.42
			0.5	-0.53	-0.09	-0.62
			1.2	-0.42	-0.35	-0.77
Morocco	0.45	0.41	0.2	-0.67	0.32	-0.35
			0.5	-0.50	-0.04	-0.54
			1.2	-0.36	-0.32	-0.68
Oman	0.38	0.41	0.2	-0.69	0.26	-0.43
			0.5	-0.54	-0.10	-0.64
			1.2	-0.43	-0.36	-0.79
Saudi Arabia	0.41	0.41	0.2	-0.68	0.29	-0.39
			0.5	-0.52	-0.07	-0.59
			1.2	-0.39	-0.34	-0.73
Tunisia	0.45	0.41	0.2	-0.67	0.33	-0.35
			0.5	-0.49	-0.04	-0.53
			1.2	-0.36	-0.32	-0.68
United Arab Emirates	0.35	0.41	0.2	-0.70	0.23	-0.47
			0.5	-0.55	-0.13	-0.68
			1.2	-0.46	-0.38	-0.83
Yemen	0.23	0.41	0.2	-0.74	0.05	-0.69
			0.5	-0.65	-0.27	-0.92
			1.2	-0.60	-0.46	-1.05
North America						
Canada	0.44	0.56	0.2	-0.71	0.39	-0.32
			0.5	-0.50	-0.07	-0.57
			1.2	-0.29	-0.51	-0.80
United States of America	0.46	0.69	0.2	-0.74	0.46	-0.28
			0.5	-0.49	-0.06	-0.55
			1.2	-0.19	-0.69	-0.88

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
South Asia						
Afghanistan	0.20	0.38	0.2	-0.74	0.00	-0.74
			0.5	-0.67	-0.27	-0.94
			1.2	-0.64	-0.41	-1.05
Bangladesh	0.26	0.38	0.2	-0.72	0.10	-0.62
			0.5	-0.62	-0.20	-0.82
			1.2	-0.57	-0.38	-0.95
India	0.27	0.38	0.2	-0.72	0.11	-0.61
			0.5	-0.62	-0.20	-0.81
			1.2	-0.56	-0.38	-0.94
Nepal	0.34	0.38	0.2	-0.69	0.19	-0.50
			0.5	-0.57	-0.13	-0.70
			1.2	-0.49	-0.34	-0.83
Pakistan	0.27	0.38	0.2	-0.71	0.11	-0.60
			0.5	-0.61	-0.19	-0.80
			1.2	-0.56	-0.37	-0.93
Sri Lanka	0.28	0.38	0.2	-0.71	0.12	-0.59
			0.5	-0.61	-0.18	-0.79
			1.2	-0.55	-0.37	-0.92
Sub-Saharan Africa						
Angola	0.30	0.42	0.2	-0.71	0.16	-0.55
			0.5	-0.59	-0.19	-0.77
			1.2	-0.51	-0.42	-0.93
Benin	0.33	0.42	0.2	-0.70	0.20	-0.50
			0.5	-0.57	-0.15	-0.72
			1.2	-0.48	-0.40	-0.88
Botswana	0.20	0.42	0.2	-0.75	0.00	-0.75
			0.5	-0.67	-0.31	-0.98
			1.2	-0.63	-0.48	-1.11
Burkina Faso	0.35	0.42	0.2	-0.70	0.23	-0.47
			0.5	-0.56	-0.13	-0.69
			1.2	-0.46	-0.38	-0.84
Cabo Verde	0.28	0.42	0.2	-0.72	0.13	-0.58
			0.5	-0.61	-0.21	-0.82
			1.2	-0.53	-0.43	-0.96
Cameroon	0.32	0.42	0.2	-0.70	0.19	-0.51
			0.5	-0.58	-0.16	-0.74
			1.2	-0.49	-0.40	-0.89
Central African Republic	0.18	0.42	0.2	-0.76	-0.04	-0.80
			0.5	-0.69	-0.34	-1.03
			1.2	-0.65	-0.50	-1.15

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
Chad	0.18	0.42	0.2	-0.76	-0.05	-0.81
			0.5	-0.69	-0.34	-1.03
			1.2	-0.66	-0.50	-1.16
Congo	0.19	0.42	0.2	-0.75	-0.02	-0.77
			0.5	-0.68	-0.32	-1.00
			1.2	-0.64	-0.49	-1.13
Côte d'Ivoire	0.37	0.42	0.2	-0.69	0.25	-0.44
			0.5	-0.54	-0.11	-0.66
			1.2	-0.44	-0.37	-0.81
Ethiopia	0.18	0.42	0.2	-0.76	-0.04	-0.80
			0.5	-0.69	-0.33	-1.02
			1.2	-0.65	-0.50	-1.15
Gabon	0.35	0.42	0.2	-0.70	0.23	-0.46
			0.5	-0.55	-0.13	-0.68
			1.2	-0.45	-0.38	-0.83
Gambia	0.34	0.42	0.2	-0.70	0.22	-0.48
			0.5	-0.56	-0.14	-0.70
			1.2	-0.46	-0.39	-0.85
Ghana	0.41	0.42	0.2	-0.68	0.29	-0.39
			0.5	-0.52	-0.08	-0.60
			1.2	-0.40	-0.35	-0.75
Guinea	0.31	0.42	0.2	-0.71	0.18	-0.53
			0.5	-0.58	-0.17	-0.75
			1.2	-0.50	-0.41	-0.91
Guinea-Bissau	0.24	0.42	0.2	-0.73	0.08	-0.65
			0.5	-0.63	-0.25	-0.89
			1.2	-0.58	-0.45	-1.03
Kenya	0.21	0.42	0.2	-0.74	0.02	-0.73
			0.5	-0.66	-0.30	-0.96
			1.2	-0.62	-0.48	-1.09
Lesotho	0.30	0.42	0.2	-0.71	0.16	-0.55
			0.5	-0.59	-0.19	-0.78
			1.2	-0.51	-0.42	-0.93
Liberia	0.22	0.42	0.2	-0.74	0.04	-0.70
			0.5	-0.65	-0.28	-0.93
			1.2	-0.60	-0.47	-1.07
Madagascar	0.18	0.42	0.2	-0.76	-0.04	-0.80
			0.5	-0.69	-0.33	-1.02
			1.2	-0.65	-0.50	-1.15
Malawi	0.27	0.42	0.2	-0.72	0.13	-0.59
			0.5	-0.61	-0.21	-0.82
			1.2	-0.54	-0.43	-0.97

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
Mali	0.41	0.42	0.2	-0.68	0.29	-0.39
			0.5	-0.52	-0.08	-0.59
			1.2	-0.40	-0.35	-0.74
Mauritania	0.37	0.42	0.2	-0.69	0.25	-0.44
			0.5	-0.54	-0.11	-0.65
			1.2	-0.43	-0.37	-0.80
Mauritius	0.38	0.42	0.2	-0.69	0.26	-0.43
			0.5	-0.54	-0.11	-0.64
			1.2	-0.43	-0.37	-0.79
Mozambique	0.25	0.42	0.2	-0.73	0.10	-0.63
			0.5	-0.62	-0.24	-0.86
			1.2	-0.56	-0.45	-1.01
Namibia	0.14	0.42	0.2	-0.78	-0.13	-0.91
			0.5	-0.73	-0.39	-1.12
			1.2	-0.70	-0.53	-1.23
Niger	0.34	0.42	0.2	-0.70	0.21	-0.49
			0.5	-0.56	-0.15	-0.71
			1.2	-0.47	-0.39	-0.86
Nigeria	0.36	0.42	0.2	-0.69	0.24	-0.46
			0.5	-0.55	-0.13	-0.68
			1.2	-0.45	-0.38	-0.83
Rwanda	0.23	0.42	0.2	-0.73	0.06	-0.68
			0.5	-0.64	-0.27	-0.91
			1.2	-0.59	-0.46	-1.05
Sao Tome and Principe	0.24	0.42	0.2	-0.73	0.07	-0.66
			0.5	-0.64	-0.26	-0.89
			1.2	-0.58	-0.46	-1.03
Senegal	0.27	0.42	0.2	-0.72	0.12	-0.60
			0.5	-0.61	-0.22	-0.83
			1.2	-0.54	-0.44	-0.98
Sierra Leone	0.26	0.42	0.2	-0.72	0.11	-0.61
			0.5	-0.62	-0.23	-0.85
			1.2	-0.55	-0.44	-0.99
South Africa	0.37	0.56	0.2	-0.72	0.32	-0.41
			0.5	-0.53	-0.16	-0.69
			1.2	-0.36	-0.59	-0.95
South Sudan	0.24	0.42	0.2	-0.73	0.08	-0.66
			0.5	-0.63	-0.25	-0.89
			1.2	-0.58	-0.45	-1.03
Sudan	0.24	0.42	0.2	-0.73	0.06	-0.67
			0.5	-0.64	-0.26	-0.90
			1.2	-0.58	-0.46	-1.04

Country	Proximity to subsistence	Income share of land	Elasticity of substitution	Elasticity of agricultural labor with respect to		
				Labor productivity	Land productivity	TFP
Swaziland	0.21	0.42	0.2	-0.74	0.03	-0.72
			0.5	-0.66	-0.29	-0.95
			1.2	-0.61	-0.47	-1.08
Togo	0.27	0.42	0.2	-0.72	0.12	-0.60
			0.5	-0.61	-0.22	-0.84
			1.2	-0.55	-0.44	-0.98
Uganda	0.21	0.42	0.2	-0.74	0.02	-0.73
			0.5	-0.66	-0.30	-0.96
			1.2	-0.61	-0.48	-1.09
Tanzania	0.23	0.42	0.2	-0.74	0.05	-0.68
			0.5	-0.65	-0.27	-0.92
			1.2	-0.59	-0.46	-1.06
Zambia	0.11	0.42	0.2	-0.80	-0.22	-1.02
			0.5	-0.76	-0.44	-1.21
			1.2	-0.74	-0.55	-1.30
Zimbabwe	0.19	0.42	0.2	-0.75	-0.01	-0.76
			0.5	-0.68	-0.32	-0.99
			1.2	-0.63	-0.49	-1.12