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Abstract

To analyse in-work poverty, we build a model in which human capital and productivity varies over time with experience, time-related obsolescence and poverty. The model reveals four possible trajectories: poverty to exclusion; permanent poverty; the emergence from poverty; poverty to non-poor worker and back to poverty. It also generates the main traits of in-work poverty in terms of skill, age, duration, and family characteristics. Both skill-biased technical change and globalisation boost in-work poverty and exclusion. When unemployment compensation is introduced, being a poor worker can be a rational choice for individuals who accept lower pay today to earn more tomorrow.

Keywords: exclusion, poverty, working poor.

JEL Classification: I32, J24.

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1. Introduction

This article provides theoretical bases for the main characteristics of the working poor as described in the empirical literature.

Even if the notion of working poverty appeared during the Great Depression and was renewed in the sixties in the United States (Harrington, 1962), the analysis of the working poor has become a major concern since the early eighties with the development of poverty in the US and the UK. Since the eighties, the increase of in-work poverty has been diagnosed in the majority of advanced countries. According to Eurostat[1] the working poor (persons who work and belong to a family situated under the poverty line[2]) make up between 3.9% and 14% of the employed population within European countries in 2010.

Today's abundant empirical literature dedicated to studying in-work poverty helps to identify the main characteristics of the working poor (Gleicher and Stevans, 2005, for an extensive study of the US case and Kalugina, 2012, for a recent survey of the literature). The working poor are firstly concentrated among the less skilled and low educated workers (Hale, 1997; Lagarenne and Legendre, 2000; Elodie et al., 2006). They are typically young and at the beginning of their working lives (Gardner and Herz, 1992; Lagarenne and Legendre, 2000; Mosisa, 2003) and they are rarely found among the middle-aged workers (Lohmann, 2008; Gutierrez Palacio et al., 2009). They normally have insecure professional positions such as temporary contracts or part-time jobs (Hale, 1997; Lagarenne and Legendre, 2000; Breuil-Genier et al., 2001; Elodie et al., 2006; OECD, 2009). The likelihood of becoming working poor increases (i) for single parents, particularly women (Gardner and Herz, 1992; Hale, 1997; Smeeding et al., 1999; Peña-Casas and Latta, 2004; Elodie et al., 2006), (ii) when belonging to a family with one unemployed parent (Kim, 1998; Breuil-Genier et al., 2001; OECD, 2001), and (iii) with the number of children within the family (Kim, 1998; OECD, 2001). Being working poor is often a transitory situation, but it is all the more enduring when the country is inhabited by a large number of poor and low educated workers (Cazenave, 2006). In-work poverty crucially depends on the amount of social transfers (Lagarenne and Legendre, 2000; OECD, 2001; Cazenave, 2006; Lohmann, 2008), even if the working poor often do not take advantage of the welfare system (Kim and Mergoupis, 1997). The welfare state also prevents long term poverty (Fouarge and Layte, 2005). General education and on-

[1] http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsdsc320&plugin=0

[2] The minimal yearly working time and the definition of the poverty line may differ between studies and countries. The literature usually follows Klein and. Rones (1989) by considering that the working poor must at least be employed for half of the year.

the-job training reduce the number of low-wage workers (Blasquez Cuesta and Salverda, 2009). Finally, restructuring and globalisation can foster working poverty (Cormier and Craypo, 2000). Gleicher and Stevans (2005) add several specificities in terms of occupation, industry and firms characteristics. Despite this large body of empirical literature, working poverty per se has rarely been investigated theoretically.

We propose a simple theoretical framework which makes it possible to analyse the working poor lifetime trajectories and to generate most of the characteristics distinguished in the empirical literature. Our main hypotheses are that (i) an individual's human capital increases with in-work experience and depreciates with time-related obsolescence, and (ii) being poor diminishes individual human capital and productivity.

The impacts of experience and obsolescence upon human capital are well established results from the Mincerian literature. The idea that poverty jeopardises productivity is familiar in Development Economics, and it is at the core of the efficiency wage approaches. Initiated by Leibenstein (1957) and Mazumdar (1959), this relation has subsequently been extended by a number of authors[3] (Mirrlees, 1975; Bliss and Stern, 1978a and 1978b; Dasdgupta and Rey, 1986 and 1987; Dasgupta 1993 etc.). The main mechanism underpinning this idea is that poverty produces a negative impact upon physical and mental capacities because of deprivation and under nutrition (Barrett, 2002; Lukaski, 2004), making thereby the individual fall into a poverty trap. In a recent paper, Jha et al. (2009) provide robust empirical evidence of the negative impact of malnutrition upon labour productivity among agricultural workers in India.

In this article, the poverty-productivity relationship is extended to the case of the working poor in advanced countries. In fact, the negative impact of poverty on productivity applies in advanced as well as in developing countries. Low quality feeding, long transportation time, poor accommodation or homelessness, poor health conditions and the impossibility of treating oneself, etc. diminish personal productivity as well as the individual's capacity to acquire new skills through experience and on-the-job training. Assuming that the individual's income depends on her/his productivity, we can define a poverty line in terms of personal productivity. We suppose that the individual's loss of productivity increases with poverty, i.e., with the distance between the productivity corresponding to the poverty line and her/his productivity beneath this line. From this simple framework, we firstly derive four possible trajectories: 1) poverty to exclusion; 2) permanent poverty; 3) working poor to non-poor

[3] See the review article of Binswanger and Rosenzweig (1984).

worker; 4) working poor to non-poor worker, and then back to working poverty. These trajectories produce several characteristics that are in line with empirical evidence: the concentration of the working poor among the less skilled and among the younger workers, and the impact of one country's skill endowment and poverty upon the duration of in-work poverty. The model is subsequently extended to analyse households, which casts light upon the family traits of the working poor such as single parent households, unemployment of one parent and the impact of the number of children. We also introduce skill-biased technical change and globalisation and we show that these developments impoverish certain workers and drive others from poverty to exclusion. All the preceding findings are related to the poverty-driven productivity depreciation. They are thus to a large extent independent from individual choices. In contrast, by assuming unemployment compensation, it is shown that to be a poor worker can be a rational decision for the individual who accepts to earn less today so as to earn more tomorrow.

Section 2 exposes the model general framework. Section 3 describes the four trajectories and their results in terms of the characteristics of the working poor. Section 4 examines three possible extensions and the derived additional characteristics. Finally, Section 5 draws our conclusions.

2. General framework

All individuals' working life durations are of one period. When arriving upon the labour market, individual *i* possesses human capital h_{i0} that is also her/his productivity.

A working individual *i* with productivity $h_i(t)$ at time *t* earns the wage $wh_i(t)$, with *w* being the real wage rate per unit of human capital. We assume that labour is the individual's only source of income.

There are two real income thresholds $\underline{I}$ and $\overline{I}$ such that (i) individual *i* is excluded from the labour market if $wh_i(t) < \underline{I}$, and (ii) individual *i* is a poor worker if $\underline{I} < wh_i(t) < \overline{I}$.

An excluded individual cannot work because her/his productivity is insufficient to provide her/him with the minimal income required to pay for food, transportation, accommodation etc., necessary for employment. Inside a household, one person can also decide to remain out of the labour market because her/his productivity is such that doing the house work is more

beneficial to her/him than working outside and paying for home services available on the market.

A poor worker is someone who works with an income under the poverty line. The income poverty line $\overline{I}$ is defined as the real income under which one individual's purchasing power is low enough to depreciate her/his productivity. The lower the individual's income under the poverty line, the higher her/his loss of productivity at each period of time[4].

We can thus determine the productivity thresholds $\underline{h} = \underline{I} / w$ and $\overline{h} = \overline{I} / w$ such that individual *i* is excluded from the labour market if $h_i(t) < \underline{h}$, and s/he is a poor worker for $\underline{h} \le h_i(t) < \overline{h}$. An individual with a productivity $h_i(t) \ge \overline{h}$ is a non-poor worker.

We call $\overline{h}$ the *poverty line* and $\underline{h}$ the *exclusion line*.

An individual who becomes working poor and remains poor (and not excluded) throughout her/his working life is said to fall into an *in-work poverty trap* (*poverty trap* hereafter), and an individual whose productivity passes below $\underline{h}$ falls into the *exclusion trap*.

Finally, an individual's productivity varies over time depending on three determinants, i.e., on-the-job experience, skill obsolescence due to time, and human capital depreciation due to poverty.

2.1. Experience and time-related obsolescence

Let us consider worker *i* who is never poor over her/his working life. Her/his productivity at time $t \in [0,1]$ depends (i) on her/his productivity h_{i0} when s/he enters the labour market, (ii) on her/his on-the-job experience, and (iii) on her/his time-related skill obsolescence.

On-the-job experience raises productivity by the amount $h_E(t) = \lambda_E(t) \times h_{i0}$, with $\lambda_E(0) = 0$, $\partial \lambda_E / \partial t > 0$ and $\partial^2 \lambda_E / \partial t^2 < 0$ (Figure 1.a). Inequality $\partial^2 \lambda_E / \partial t^2 < 0$ signifies that the marginal productivity gain from experience is decreasing.

Time-obsolescence lowers productivity by the amount $h_O(t) = \lambda_O(t) \times h_{i0}$, with $\lambda_O(0) = 0$, $\partial \lambda_O / \partial t > 0$ and $\partial^2 \lambda_O / \partial t^2 > 0$ (Figure 1.a). Inequality $\partial^2 h_O / \partial t^2 > 0$ signifies that the marginal time-obsolescence is increasing.

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[4] In most of the empirical studies, the working poor are persons who belong to the working force, which comprises unemployed workers who are actively job-hunting. Our definition is more restrictive since only those working are considered. This is to avoid the analysis of involuntary unemployment that is not part of our study. In addition, we firstly focus on individuals. We introduce families in Section 4, which allows a definition of a poor worker as someone who works and lives in a poor family.

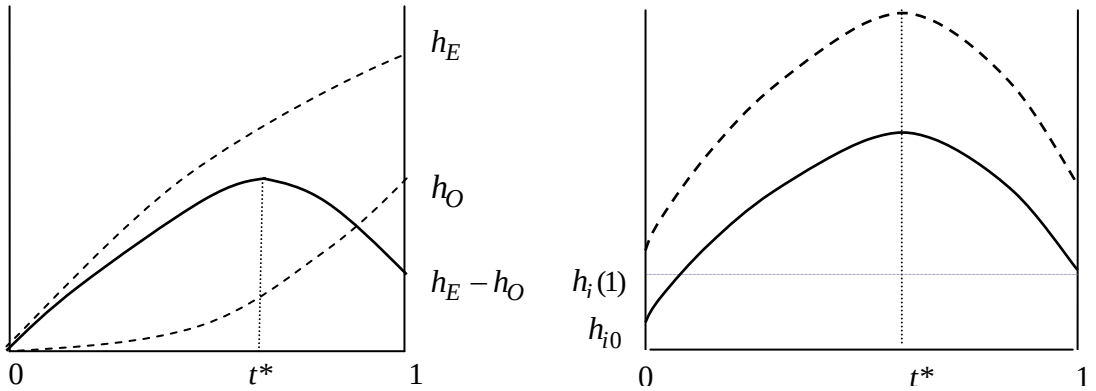
We suppose that there is a time $t^* \in [0,1]$ from which the negative obsolescence effect dominates the positive experience effect. Consequently, productivity follows an inverted-U curve over the individual's working life (Figure 1.a).

The productivity of a worker who is never poor varies over her/his working life $[0,1]$ according to the following function (Figure 1.b):

$$h_i(t) = h_{i0} + h_E(t) - h_O(t) = h_{i0}\left(1 + \lambda_E(t) - \lambda_O(t)\right) \quad (1)$$

We also suppose that $h_i(1) = h_{i0}\left(1 + \lambda_E(1) - \lambda_O(1)\right) > h_{i0}$, which signifies that the decrease in productivity (without accounting for the impact of poverty) that occurs from t^* to 1 is lower than its increase from 0 to t^*. This can be seen as a realistic assumption. Because of the shape of function $h_i(t)$, h_{i0} is thus the individual's lowest productivity over her/his working life if s/he is never poor, which establishes the following lemma:

Lemma 1: Assume that $\bar{h}$ does not increase over time. Then, an individual who is not working poor when s/he enters the labour market never becomes poor.



(a) **(b)**

Figure 1. Functions $h_E(t)$ and $h_O(t)$ (a), and $h_i(t)$ (b)

It can finally be noted that $h_{i0} > h_{j0} \Rightarrow h_{i0}\left(1 + \lambda_E(t) - \lambda_O(t)\right) > h_{j0}\left(1 + \lambda_E(t) - \lambda_O(t)\right)$, $\forall t \in [0,1]$, as long as i is not in the exclusion trap. This shows that the initial hierarchy of

productivity across non-poor individuals is maintained all through working life (in Figure 1.b, the dashed curve represents the productivity of a worker who is initially more productive).

2.2. Poverty-related productivity depreciation

Poverty jeopardises productivity. This depreciation can take two forms. It firstly consists in a temporary reduction, due to immediate tiredness that disappears as soon as the individual quits poverty. It also consists in lasting productivity losses that result from health downgrading, knowledge shortfalls and inability to acquire new skills through experience and training. We centre our analysis upon this last depreciation[5].

Let us consider individual *i* who becomes working poor at time θ. From then, and until time θ' when s/he quit poverty, i.e. as long as $h_i(t) < \overline{h}$, individual *i* 's productivity suffers a poverty-related depreciation $\Lambda_D(i,\theta,\theta') \times h_i(\theta)$ defined by:

$$\Lambda_D(i,\theta,\theta') = \int_{\theta}^{\theta'} \lambda_D(\delta_i(t))\,dt \qquad (2)$$

with $\delta_i(t) = \overline{h} - h_i(t) > 0$

$\lambda_D(\delta_i)$ is the instantaneous productivity depreciation caused by poverty. At any time *t*, this depreciation depends on the difference between the poverty line $\overline{h}$ and the productivity of the individual $h_i(t)$, i.e. on $\delta_i(t) = \overline{h} - h_i(t)$ with $\lambda_D(\delta_i) = 0$ for $\delta_i \le 0$, and $\frac{\partial \lambda_D}{\partial \delta_i} > 0$ for $\delta_i > 0$. These features result from the fact that, for an individual below the poverty line, higher poverty induces a deeper decrease in her/his health and capacities that jeopardises her/his productivity both by lowering the acquisition of new skills through experience and training, and by accelerating the depreciation of her/his existing human capital.

Given the characteristics of function $h_D(\delta_i)$, the following features are straightforward:

1) $\Lambda_D(i,\theta,t)$ increases as long as the individual remains poor: $\delta_i(t) > 0 \Rightarrow \partial \Lambda_D / \partial t > 0$

2) If individual *i* becomes working poor at time θ and leaves poverty at time θ', then the depreciation $\Lambda_D(i,\theta,\theta') \times h_{i0}$ accumulated over the period $[\theta,\theta']$ remains constant as long as the individuals stays out of poverty. Consequently: $\delta_i(t) \le 0 \Rightarrow \partial \Lambda_D / \partial t = 0$.

[5] Inserting the former would merely add a new channel of depreciation without modifying the analysis.

3) Assume that over the period $[0,t]$ individual *i* has been working poor during the *n* sub-periods $[\theta_1,\theta_1']$,$[\theta_2,\theta_2']$,…,$[\theta_n,\theta_n']$, and non-poor the rest of the time. Then, her/his total poverty-related depreciation of productivity over the time period $[0,t]$ is $h_{i0}\times\Lambda_D(i,0,t)=h_{i0}\sum_{j=1}^{n}\Lambda_D(i,\theta_j,\theta_j')$.

4) Assume that $\delta_i(t)>0$. Then $\partial^2\Lambda_D/\partial t^2>0$ when $\delta_i(t)$ increases with time, and $\partial^2\Lambda_D/\partial t^2<0$ when $\delta_i(t)$ decreases with time.

Finally, since in function $\Lambda_D(i,0,t)$ the individual *i*' s characteristic is totally defined by the initial human capital endowment h_{i0} (through $h_{i0}(1+h_T(t)-h_O(t))$ and $\delta_i(t)=\overline{h}-h_i(t)$), we can write without loss of generality $\Lambda_D(i,0,t)=\Lambda_D(h_{i0},0,t)$.

2.3. Productivity during working life

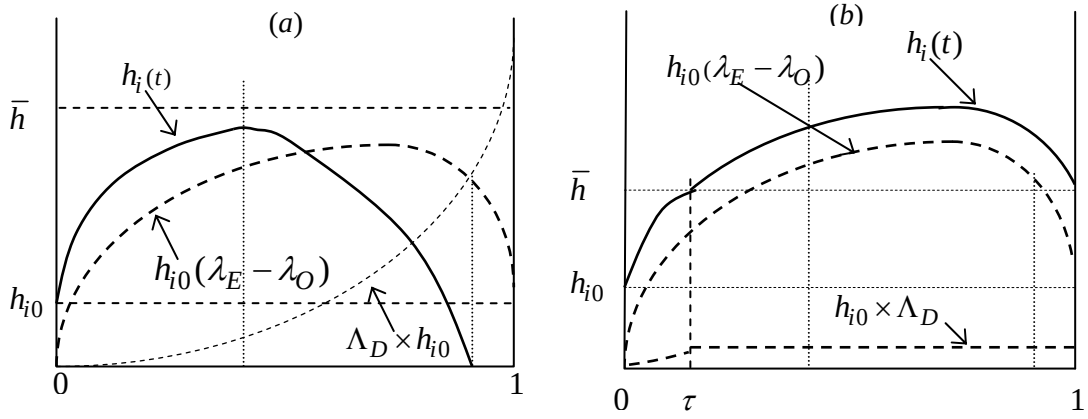
We can now insert functions $\lambda_E(\bullet)$, $\lambda_O(\bullet)$ and $\Lambda_D(\bullet)$ into the function $h_i(t)$ that defines individual *i*'s productivity at time *t*, which yields:

$$h_i(t)=h_{i0}\left(1+\lambda_E(t)-\lambda_O(t)-\Lambda_D(h_{i0},0,t)\right) \qquad (3)$$

Lemma 2: *Assume that productivity* $h_i(t)$ *decreases at time* $\tau\in[0,1]$. *Then productivity* $h_i(t)$ *continues to decrease in all the subsequent periods* $[\tau,1]$ *of individual i's working life.*

Proof: Productivity $h_i(t)$ decreases at time $\tau \Leftrightarrow \frac{\partial h_i}{\partial t}<0 \Leftrightarrow \frac{\partial\Lambda_D}{\partial t}+\frac{\partial\lambda_O}{\partial t}>\frac{\partial\lambda_E}{\partial t}$ for $t=\tau$. As $\frac{\partial^2\lambda_O}{\partial t^2}>0$, $\frac{\partial h_i}{\partial t}<0\Rightarrow\frac{\partial^2\Lambda_D}{\partial t^2}>0$, and $\frac{\partial^2\lambda_E}{\partial t^2}<0$, then $\frac{\partial\Lambda_D}{\partial t}+\frac{\partial\lambda_O}{\partial t}>\frac{\partial\lambda_E}{\partial t}$ and $\partial h_i/\partial t<0$ for all the subsequent periods.

The shapes of functions $\lambda_E(\bullet)$, $\lambda_O(\bullet)$, $\Lambda_D(\bullet)$, and $h_i(t)$ are described in Figure 2.



Figures 2: Productivity paths

In Figure 2.a, the reversal of function $h_i(t)$ occurs under the poverty line $\bar{h}$, and $\Lambda_D(h_{i0},0,t)$ increases throughout working life $[0.1]$. Contrarily, in Figure 2.b the individual definitely quits the poverty trap at time τ. Henceforth, $\Lambda_D(h_{i0},0,t)$ remains constant: $\Lambda_D(h_{i0},0,t) = \Lambda_D(h_{i0},0,\tau)$, $t \geq \tau$.

Lemma 3: *Assume that at time* $\tau \in [0,1]$, *individual i is working poor with a decreasing productivity. Then, individual i falls, either into a poverty trap, or into the exclusion trap.*

Proof: This is straightforward from Lemma 2.

Lemma 4: *If* $h_{i0} > h_{j0}$, *then* $h_i(t) > h_j(t)$ *for as long as individual i is not in the exclusion trap.*

Proof: $h_i(t) = h_{i0}(1+\lambda_E(t)-\lambda_O(t)-\Lambda_D(h_{i0},0,t))$, with $\Lambda_D(h_{i0},0,t) = \int_0^t \lambda_D(\delta_i(x))dx$, $\partial\lambda_D / \partial\delta_i > 0$ and $\delta_i(x) = \bar{h} - h_i(x) > 0$. Since $h_{i0} > h_{j0}$, then for all $t \in [0,1]$, $h_{i0}(1+\lambda_E(t)-\lambda_O(t)) > h_{j0}(1+\lambda_E(t)-\lambda_O(t))$, which induces $\delta_i(t) < \delta_j(t)$ and $\lambda_D(\delta_i(t)) \leq \lambda_D(\delta_j(t))$, thus $\Lambda_D(h_{i0},t) < \Lambda_D(h_{j0},t)$ and finally $h_i(t) > h_j(t)$.

Lemma 4 shows that the initial hierarchy of productivity across individuals is maintained throughout working life.

3 Trajectories

Let us assume (i) that thresholds $\underline{h}$ and $\overline{h}$ remain unchanged over time (this assumptions will be released hereafter) and (ii) that no individual is below the exclusion trap when entering the labour market. Hence, all individuals are initially, either non-poor workers, or working poor.

We know that an individual who is not poor when s/he begins to work never becomes working poor (Lemma 1). Consequently, we centre the analysis upon those individuals who are below the poverty line when entering the labour market.

We firstly present the four possible working poor trajectories. From these, we derive certain characteristics of the working poor.

3.1. The four trajectories

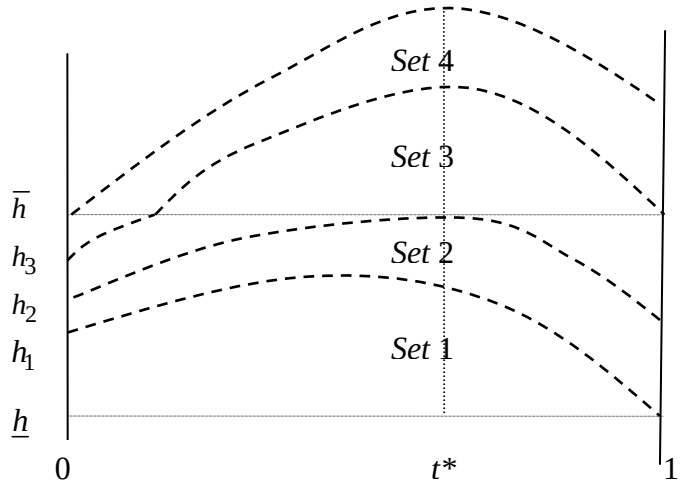


Figure 3: The four sets of working poor trajectories

Lets us define the following three human capita levels (Figure 3):

1) h_1 is such that $h_1 \in \left[\underline{h}, \overline{h}\right]$ and $h_1\left(1+\lambda_E(1)-\lambda_O(1)-\Lambda_D(h_1,0,1)\right)=\underline{h}$.

2) h_2 is such that (i) $h_2 \in \left[\underline{h}, \overline{h}\right]$, (ii) $\overline{h} = \max_{t\in[0,1]}\left[h_2\left(1+\lambda_E(t)-\lambda_O(t)-\Lambda_D(h_2,0,t)\right)\right]$ and (iii) $h_2\left(1+\lambda_E(t)-\lambda_O(t)-\Lambda_D(h_2,0,1)\right) \geq \underline{h}$. From the characteristics of functions $\lambda_E(\bullet)$, $\lambda_O(\bullet)$ and $\Lambda_D(\bullet)$, it is clear that an individual initially endowed with human capital h_2 attains her/his highest lifetime human capital $\overline{h}$ at time t^*.

3) h_3 is such that $h_3 \in \left[\underline{h}, \overline{h}\right]$ and $h_3\left(1+\lambda_E(1)-\lambda_O(1)-\Lambda_D\left(h_3,0,1\right)\right)=\overline{h}$.

From these definitions, Figure 3 depicts the lifetime trajectories of those individuals who respectively possess the initial human capital h_1, h_2 and h_3.

Proposition 1: *Consider individual i with the human capital endowment* $h_{i0} \in \left]\underline{h}, \overline{h}\right[$ *when s/he enters the labour market. Then:*

a) Individual i falls in the exclusion trap during her/his working life if $h_{i0} \in \left]\underline{h}, h_1\right[$ *;*

b) Individual i remains working poor throughout her/his working life if $h_{i0} \in \left[h_1, h_2\right]$ *;*

c) Individual i shifts from working poverty to non poverty, and subsequently goes back to working poverty for the rest of her/his life if $h_{i0} \in \left]h_2, h_3\right[$ *;*

d) Individual i definitely leaves poverty at a moment of her/his working life if $h_{i0} \in \left]h_3, \overline{h}\right[$.

Proposition 1 provides the possible four trajectories of a poor worker. It also determines the four sets of trajectories depicted in Figure 3.

It can be noted that when the negative impact of poverty on productivity is sufficiently strong, Set 2 vanishes because the trajectory with the highest human capital being $\overline{h}$ (with the initial productivity h_2) falls into the exclusion trap before the end of the working life. In this case as depicted in Figure 4, nobody remains working poor throughout her/his working life. Set 1' now gathers all the individuals who are successively poor and excluded, and Set 2' those who are successively poor, non-poor and finally excluded.

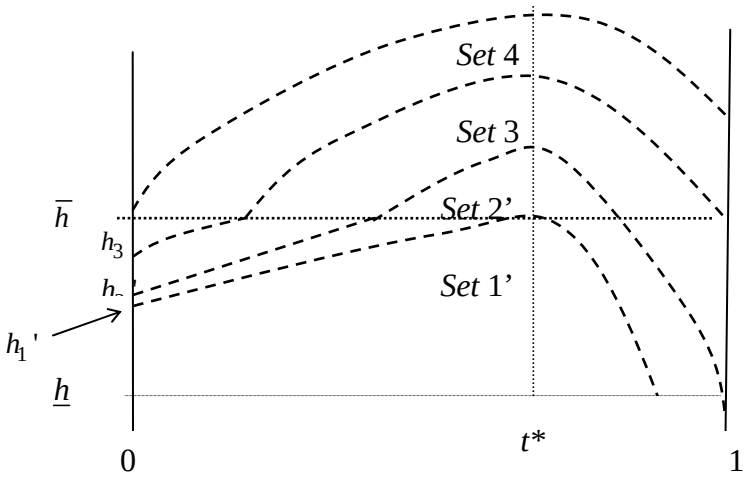


Figure 4: The four sets of working poor trajectories

Finally, it can be noted that inserting the poverty-related depreciation $\Lambda_D\left(h_{i0},0,t\right)$ into the determination of productivity $h_i(t)$ modifies the productivity trajectory in two ways:

1) it causes certain poor workers to fall into the exclusion trap (those inside Set 1 in Figure 3, and those inside Set 1' and the lowest part of Set 2' in Figure 4), which would not be the case without poverty-related depreciation (since $h_{i0} = \underline{h} \Rightarrow h_i(t) > \underline{h}, t \in \left]0,1\right]$)

2) It reduces the amount of working poor among the middle aged and senior workers because a number of them now fall into the exclusion trap.

3.2. Working poor characteristics

The presence of individuals inside the exclusion and poverty traps depends (i) on the shapes of functions $\lambda_E(\bullet)$, $\lambda_O(\bullet)$ and $\Lambda_D\left(\bullet\right)$, and (ii) on the initial distribution of individuals on the productivity spectrum. Assuming that these functions and the initial distribution of human capital endowments are such that poverty and exclusion do exist, the model provides several outcomes that are consistent with the observed characteristics of the working poor as revealed by the empirical literature:

1) Poverty is concentrated among the less skilled. This directly stems from the model assumption that income is proportional to productivity, i.e. human capital.

2) The working poor are concentrated among the young workers, the middle aged and older workers being less affected. As a matter of fact, all the individuals who are working poor at a moment in their lives (sets 1 to 4 in Figure 3) must have been poor as youngsters (Lemma 1). In contrast, only these belonging to the lowest part of set 3, to set 2 and to the highest part of set 1 are working poor when attaining middle-age. In addition, only those belonging to sets 2 and 3, and to the very highest part of set 1 are working poor once they become elderly. Obviously, the proportion of each age group within the working poor population depends on the distribution of the individuals over the segment $\left]\underline{h},\bar{h}\right[$ at the initial time (e.g., if all the working poor belong to set 2, then all the age groups are equally represented). However, the youngsters are typically the most likely to be working poor. The relative positions of the older and the middle-aged are more ambiguous, but it is to be expected that the former will be more numerous than the latter. This is because all the individuals inside sets 2 and 3 (plus a very small part of set 1) are working poor when they become elderly, whereas only set 2 plus a part of sets 3 and 1 are middle-aged working poor.

The higher number of elderly compared to middle-aged worker is even reinforced when the middle-aged workers can improve their productivity through continuous training, which is typically more difficult for the elder.

3) The duration of working poverty depends on the set an individual belongs to. The individuals inside Set 2 experience the longest duration. This is followed by the lowest part of Set 3 and the highest part of Set 1. Finally, the shortest durations correspond to Set 4 and the lowest part of Set 1. As a consequence, when the initial productivity moves downwards from $\bar{h}$ to $\underline{h}$, the duration of in-work poverty follows an inverted-U curve, growing from 0 to 1 when human capital increases from $\bar{h}$ to h_2, remaining at 1 from h_2 to h_1, and decreasing from 1 to 0 when from h_1 to $\underline{h}$. Between countries, there is thus no clear monotonic relation between the duration of in-work poverty on the one hand, and the levels of poverty and skill on the other. Two reasons explain this. Firstly, the U-inverted shape results in the duration being shorter for countries with poverty profiles situated, either just beneath the poverty line, or far below this line, i.e. close to the exclusion line. The former are characterised by low poverty and few unskilled workers, and the latter with both high poverty and a high proportion of very unskilled workers. Secondly, there is no simple way to compare countries in terms of poverty and skill. On the one hand, the proportion of poor inside the working population reveals little about real poverty because this primarily depends on the degree of poverty, i.e., on the initial distribution of the poor over segment $]\underline{h}, \bar{h}[$. On the other hand, the same average skill can correspond to very different distributions of human capital. For instance, an average initial skill inside segment $[h_1, h_2]$ (Set 2 in Figure 3) can refer to a large majority of poor inside Set 2, or to the working poor being distributed between Set 4 and the lower part of Set 1. The fist case corresponds to a lengthy duration of working poverty, whereas the second implies a short duration. However, if the different countries implement unemployment subsidies and/or social transfers that allocate to all the non-working individuals an income that is higher than the exclusion line income, then the individuals initially situated just above the exclusion line will not go to work, and they will thereby never be working poor.

4. Extensions

Three possible extensions are now examined. We firstly extend the model to the case of households with parents and children. We secondly discuss the possible moves in thresholds $\underline{h}$ and $\overline{h}$. We finally introduce social policies, and we show that to become working poor can be an inter-temporal choice for the individual when accounting for unemployment compensation.

4.1. Households

The model is now extended to the case of households with parents and children. This extension makes it possible to analyse the impacts of the number of parents and the number of children upon the probability of being working poor.

To do this, we define the equivalent productivity $\eta_i = k_i / e(n_i)$ where subscript *i* denotes household *i* that comprises the parent(s) and the child(ren) inside the household, k_i is the sum of the parents' human capital (productivity), $e(n_i)$ the equivalence scale with n_i the number of individuals inside the family and $1 \leq e(n_i) \leq n_i$ [6]. The equivalent productivity η_i can be interpreted as the productivity of the household per unit of individual consumption, provided that the family consumption is characterised by economies of scale.

From this framework, it is clear that the household total income is $I_i = w \times k_i = w \times e(n_i) \times \eta_i$, and its equivalent income is $F_i = w \times \eta_i$.

The exclusion and poverty thresholds can now be defined in terms of equivalent income, $\underline{F}$ and $\overline{F}$. Hence, the exclusion and poverty traps now become $\underline{\eta} = \underline{F} / w$ and $\overline{\eta} = \overline{F} / w$.

Within this modified framework, the model can be developed similarly to Section 3. As in the initial model, several productivity profiles can be determined throughout the households' working life. Identically, four trajectories are possible for a household that is initially working and poor. However, three additional outcomes are now forthcoming:

1) Ceteris paribus, i.e. for a given household productivity k_i, an increase in the number of children decreases the productivity per unit of family members, which increases the

[6] Following Buhmann et al. (1988), we could define $e(n_i) = n_i^{\alpha}$, $0 \leq \alpha \leq 1$. We could also define $e_i = e(p_i, c_i)$ as a weighted sum in which p_i and c_i are respectively the number of parents and children inside the household, and each parent accounts for one unit whereas each child accounts for less.

probability of the parents becoming working poor. This is in line with the results of Kim (1998) and OECD (2001).

2) For a given endowment of each parent in human capital and a given number of children, the loss of one parent in a family causes certain households to slip under the poverty line. This is the case when $k_{i1}/e(n_i-1) < \overline{\eta} < (k_{i1}+k_{i2})/e(n_i)$, with k_{ij}, $j=1,2$, the productivity of parent *j* within family *i* and parent 1 being the one who takes charge of the children. As a consequence, the probability of being a working poor household is typically higher in the single parent families, particularly when the parent who raises the children is a low paid woman, which is a clear result of the empirical literature on this subject (Hale, 1997; Smeeding et al., 1999; Peña-Casas and Latta, 2004; Elodie et al., 2006).

3) If one of the two parents is under the exclusion line, s/he is then permanently unemployed but accounts for one person inside the family. This increases the probability of such families being under the poverty line, and thus the probability of the working parent being working poor, which is in accordance with Kim (1998), Breuil-Genier et al. (2001) and OECD (2001).

4.2. Changes in the poverty and exclusion lines

We have assumed until now that the exclusion and poverty lines $\underline{h}$ and $\overline{h}$ (or $\underline{\eta}$ and $\overline{\eta}$) remain unchanged over time. However, a move in the real wage per unit of human capital *w* displaces these lines because $\underline{h} = \underline{I}/w$ and $\overline{h} = \overline{I}/w$. In addition, the real incomes $\underline{I}$ and $\overline{I}$ can themselves vary with time, e.g. when the prices of certain basic consumptions (food, transportation, accommodation etc.) increase more than the general price index., or when the access to new services is needed to enter the labour market.

In a number of advanced countries, the rise in the skill premium and the (relative or absolute) decrease in the real wage of the less skilled are now well documented. The countries where these developments have been the most significant are typically those showing the highest proportion of working poor (e.g., the US and the UK). In addition, three main explanations have been given to these developments, namely, globalisation (North-South trade), technical progress, and changes in institutions (see Chusseau et al., 2008, and Machin, 2008, for recent reviews).

Since the working poor are concentrated among the less skilled workers, we now examine the mechanisms by which technical change and globalisation can move up the poverty and

exclusion lines, and thereby increase poverty and exclusion. For this, we suppose (i) that there are two types of position, skilled and less skilled, and (ii) that there is a human capital threshold $\tilde{h}$ above which an individual can occupy a skilled position, and beneath which s/he can only fill an unskilled position. In each type of position, an individual with human capital *h* is paid proportionally to her/his human capital, i.e. $w_H \times h$ is she works as a skilled worker, and $w_L \times h$ as an unskilled worker. We assume $w_H > w_L$, i.e., that an individual always prefers to work as a skilled worker if s/he can. We also assume that there are unskilled workers who are not poor ($\tilde{h} > \bar{I} / w_L$) which implies that skilled workers are never poor ($\tilde{h} > \bar{I} / w_H$). The poverty line is thus $\bar{h} = \bar{I} / w_L$ and the exclusion line $\underline{h} = \underline{I} / w_L$.

4.2.1. *Skill-biased technical change (SBTC)*

We suppose that the economy produces one good (the price of which is 1) with a neoclassical function $Y_t = F_t(H_t, L_t)$ where H_t and L_t are respectively the skilled and unskilled labour used in production at time *t*. To account for SBTC, we assume that there is no increase in total factor productivity but that technical change raises the relative demand for skill $H_t / L_t = g(a_t, w_t)$, $\partial\left(H_t / L_t\right) / \partial w_t < 0$ and $\partial\left(H_t / L_t\right) / \partial a_t > 0$, where $w_t = w_{H,t} / w_{L,t}$ is the skill premium and coefficient a_t indicates the skill intensity due to technology[7]. SBTC takes the form of an increase in a_t over time. Within such a framework and for given endowments of $H = \sum_{h_i \geq \tilde{h}} h_i$ and $L = \sum_{h_i < \tilde{h}} h_i$, SBTC increases $w_{H,t}$ and lowers $w_{L,t}$. Hence, SBTC increases both the poverty line $\bar{h}_t = \bar{I} / w_{L,t}$ and the exclusion line $\underline{h}_t = \underline{I} / w_{L,t}$ over time, which throws certain workers into poverty and certain poor workers into exclusion. Note that this development can be counteracted by a technological change that increases total factor productivity, thereby raising the real wage of both skilled and unskilled workers.

4.2.2. *Globalisation*

Let us suppose a Heckscher-Ohlin-Samuelson framework with two countries (the North and the South) two factors (skilled and unskilled labour), and two goods (one skill-intensive and

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[7] For instance, $a_t = \alpha_t (1 - \alpha_t)^{-1}$ for the Cobb-Douglas technology $Y = A H^{\alpha_t} L^{1-\alpha_t}$ and for the CES technology $Y = A\left(\alpha_t H^{\rho} + (1 - \alpha_t) L^{\rho}\right)^{1/\rho}$, $0 \leq \alpha_t \leq 1$.

the other unskilled labour-intensive). The North is relatively better endowed with skilled labour. Globalisation takes the form of an increase in the size of the South. This depicts the fact that an increasing number of developing countries opt for trade liberalization and enter thereby the globalized economy. Both the northern and southern relative endowments with skilled labour are assumed to be constant. We suppose free trade between the North and the South. Within such a framework, the increase in the size of the South (globalisation) lowers the real wage of unskilled workers (w_L) and raises the real wage of skilled workers (w_H) in the North. The decrease in w_L moves both the poverty and exclusion lines upwards. As previously, this drives certain workers into poverty and certain working poor into exclusion.

Consequently, by introducing skill biased technical change and globalisation into the model, we have moved the poverty and exclusion lines upwards. These developments throw certain workers into poverty, and plunge certain poor workers into exclusion.

4.3. Social transfers and skill enhancing policies

We firstly analyse the impacts of two social transfers, i.e., payments to the poor and unemployment compensation. We subsequently discuss the impact of skill enhancing policies directed towards the poor.

4.3.1. *Transfers to the poor*

We consider the transfers given to the poor, regardless of whether they work or not.

Two types of transfer may be distinguished. Firstly, in the case of a lump sum transfer, all the incomes are increased by the same amount *f*. This enables (i) the upper part of the working poor on the productivity scale (these belonging to segment $\left[\overline{h} - f / w, \overline{h}\right]$) to escape from poverty, and (ii) the upper part of the excluded poor (these belonging to segment $\left[\underline{h} - f / w, \underline{h}\right]$) to become working poor. The impact upon the number of working poor is not straightforward because it depends on the distribution of the individuals under the poverty line. This is in line with Lohmann's calculations (2008)

Secondly, in the case of transfers proportional to poverty, the transfer to individual *i* beneath the poverty line can be modelled as $f_{i,t} = w\alpha(\overline{h} - h_i(t))$ with $0 < \alpha < 1$. Individual *i*'s income then becomes $wh_i(t) + f_{i,t} = \alpha w\overline{h} + (1-\alpha)wh_i(t)$. This enables nobody to escape from

poverty ($\alpha w\bar{h} + (1-\alpha) wh_i(t) < w\bar{h}$), but this increases the income of all the individuals under the poverty line by an amount that is proportional to poverty. As a consequence, (i) the individuals inside the segment $\left[\underline{h}, \frac{\underline{h} - \alpha\bar{h}}{1-\alpha}\right]$ move from exclusion to poverty, and (ii) all the poor workers become less poor. The impact upon the number of working poor is ambiguous. At the moment when it is created, the transfer increases the number of working poor. However, its subsequent impact depends on the distribution of the individuals inside the segment $\left[\bar{h}, \frac{\underline{h} - \alpha\bar{h}}{1-\alpha}\right]$.

4.3.2. *Unemployment compensation: the 'choice' of in-work poverty*

In the model developed in Section 3, being a working poor was totally determined by the individual's position in terms of productivity when joining the labour market and was devoid of any personal decision. However, an individual with an initial productivity inside interval $\left[\underline{h}, \bar{h}\right]$ may face several choices[8]. Firstly, if there is unemployment compensation, s/he may prefer receiving these subsidies to becoming working poor. Secondly, s/he can opt for illegal activities such as moonlighting or crime.

We analyse here the case of a lump sum unemployment pay-out. This changes the model because individuals with productivity inside interval $\left[\underline{h}, \bar{h}\right]$ have the choice between being working poor and being unemployed and receiving compensation. This choice is inter-temporal since it depends on the related lifetime income. We show that, even if the unemployment compensation is higher than the income perceived as a poor worker, the individual may choose to be working poor over a limited period if this allows her/him to earn more in the longer term because of the inverted-U shape of the lifetime income trajectory.

We suppose that the utility of individual *i* can be defined in terms of her/his income during her/his life $v_i = \int_0^1 \rho^t I_i(t)\, dt$, with $I_i(t)$ being the real income at time *t* and ρ the discount factor (identical for all individuals). We also assume that:

1) The poverty line and the real wage per unit of human capital remain unchanged during the individual's working life.

[8] Gleicher and Stevans (2005) propose a model where the choice between working in the poverty sector and working outside this sector depends on the cost of entering the latter, particularly in terms of education.

2) The real unemployment subsidy s_U is given to an individual as long as s/he remains unemployed. The subsidy s_U is such that $w\underline{h} < s_U \leq w\bar{h}$, i.e., the subsidy is not higher than the income on the poverty line, but above the income on the exclusion line.

3) Being unemployed, the individual suffers a human capital depreciation equal to the sole time-related depreciation.

We denote $v_{Wi}\left(h_{i\theta},\tau,\tau'\right)=\int_{\tau}^{\tau'}\rho^t wh_i\left(h_{i\theta},t\right)dt$ and $v_U\left(\tau,\tau'\right)=\int_{\tau}^{\tau'}\rho^t s_U dt=\frac{\rho^{\tau'}-\rho^{\tau}}{\log\rho}s_U>0$.

Thus, $v_{Wi}\left(h_{i\theta},\tau,\tau'\right)$ is the utility individual *i* who began to work at time $\theta\leq\tau$ receives from working over the period $[\tau,\tau']$. $v_U\left(\tau,\tau'\right)$ is the utility received by any individual who remains unemployed over the same period.

Let us consider an individual whose initial productivity is such that s/he cannot be a non-poor worker at her/his entry in the labour market ($h_{i0}<\bar{h}$). Because of the characteristics of function $h_i\left(h_{i0},t\right)$, the following features always hold:

1) If $wh_{i0}<s_U$ and $\partial h_i(t)/\partial t<0$ for $t=0$, then individual *i* would always earn less that the unemployment subsidy when working. S/He logically chooses to remain unemployed during her/his whole working life and the related utility is $v_U\left(0,1\right)=(\rho-1)s_U/\log\rho$.

2) If $wh_{i0}>s_U$ and $\partial h_i(t)/\partial t<0$ for $t=0$, then individual *i* chooses to work over the period $]0,\theta]$ such that $wh_i\left(\theta\right)=s_U$, and she chooses to remain unemployed over the period $]\theta,1]$. Her/his lifetime utility is $v_i=v_U\left(0,\theta\right)+v_{Wi}\left(\theta,1\right)=(\rho^{\theta}-1)s_U/\log\rho+\int_{\theta}^{1}\rho^t wh_i\left(h_{i0},t\right)dt$.

3) If $wh_{i0}>s_U$ and $\partial h_i(t)/\partial t>0$ for $t=0$, then individual *i* chooses to work over her/his whole working life and her/his lifetime utility is $v_{Wi}\left(0,1\right)=\int_0^1\rho^t wh_i\left(h_{i0},t\right)dt$.

4) If $h_{i0}<s_U/w$ and $\partial h_i(t)/\partial t>0$ for $t=0$, several combinations between working and being unemployed are possible during her/his working life.

Firstly, the individual may accept to work for a wage $wh_i(t)$ lower that the unemployment subsidy s_U at the beginning of her/his working life if this allows her/him to maximise her/his lifetime utility. As a matter of fact, the initial loss due to a wage lower than the subsidy can subsequently be offset by the productivity gains stemming from on-the-job experience. Since this gain is nil when the individual does not work, and since s/he then suffers the time-related productivity loss (obsolescence), her/his rational choice consists in 'earning less today in order

to earn more tomorrow'. Obviously, the possibility of such situations critically depends on the discount factor ρ. When time preference is high, the future gains are highly depreciated and the situation described here is rather unlikely. In addition, an individual who has worked throughout her/his life can decide to become unemployed at the end of her/his working life. This is when her/his declining productivity falls under s_U / w.

Secondly, the individual may decide to be unemployed and receive the subsidy s_U throughout her/his life. This corresponds to the case $v_{Wi}(0,1) < v_U(0,1)$.

The discussion above shows that:

1) Introducing a compensation s_U for all the unemployed causes the working poor to shift to unemployment at the moment when $wh_i(t)$ becomes lower than s_U when the individual is on the descending side of the curve $h_i(t)$. This modifies the profile of the trajectories revealed in Section 3 and reduces the number of elderly among the working poor.

2) To be working poor may be a choice of the individual. In particular, s/he can decide to earn less than the unemployment compensation in the early stage of her/his working life so as to earn more afterwards. Note that, in the case $s_U \geq w\bar{h}$, s/he can even choose not to move out of poverty in the short term so as to achieve a better position in the longer term.

4.3.3. *Skill enhancing policies*

Increasing the individuals' skill level to enable them to pass beyond the poverty line at the beginning their working lives is clearly an efficient means to reducing in work poverty because an individual who enters the labour market above the poverty line never becomes poor. In addition, training during the working life that enhances productivity is another efficient means to combat working poverty, particularly when globalisation and/or technical change displaces the poverty line upwards.

5 Conclusion

A model has been built so as to study the possible trajectories of an individual who is working poor. The model is based (i) on a definition of the poverty line in terms of personal productivity, (ii) on the assumptions that experience increases productivity during working life whereas obsolescence and poverty depreciates the worker's productivity. From this

simple framework, we have determined four possible trajectories in which the working poor can (i) fall into the exclusion trap, (ii) remain poor throughout her/his life, (iii) escape from poverty, and (iv) firstly depart from poverty to subsequently fall back into it. From this model and its extension to the case of families, we derive the main characteristics of the working poor as revealed in the empirical literature in terms of skill, age, duration of poverty, family characteristics etc. We also show that globalisation and skill biased technical change tend to increase both poverty and exclusion. Finally, within a lifetime inter-temporal perspective, being a working poor and earning less than the unemployment compensation can be a rational decision by the individual when this allows her/him to increase her/his earning at a later stage. The framework described here is rather simple and it could be extended in several directions. Firstly, we have considered the number of persons in the family as unchanged over time. The assumption that the children quit the family at a certain age would provide a more accurate picture that changes the profile of the household trajectory. This would reinforce the finding that in-work poverty primarily concerns young households. Similarly, assuming stochastic shocks that modify the individuals' productivity (sickness, industrial restructuring that renders obsolete the human capital accumulated through experience) could cause certain households who were not initially poor to fall into the poverty trap. Finally, illegal activities such as moonlighting or crime could be introduced as a possible choice of the individual in addition to in-work poverty and unemployment with compensation.

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