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VIRTUAL SOCIAL CURRENCIES FOR UNEMPLOYED PEOPLE: SOCIAL NETWORKS AND JOB MARKET ACCESS

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ABSTRACT

Complementary currencies develop all around the world, taking various forms (material or immaterial) and fulfilling various functions. They are frequently introduced in order to promote local economy development and to fight against social exclusion. In this paper, we analyze the particular case of virtual currency circulation inside a local community of unemployed people. We elaborate on the assumptions that the organization of LETS and the circulation of complementary currencies have two properties: (i) they help unemployed workers to overcome the double coincidence of want necessity of an informal sector founded on barter exchange; (ii) they contribute to maintain and develop unemployed workers' skills and employability of unemployed workers outside job. We study the global properties of a job market associating traditional short-term and long-term unemployment to the organization of LETS. Using a search theoretic model, we find that the initial level of trust of agents in the complementary currency(cies) but also the effective properties of this(ese) currency(cies) inside the LETS are crucial for LETS to become survive and becoming permanent. We also find that if the stationary equilibrium of the job-market includes LETS, then LETS have a positive influence on the rate of employment, on the expected utility of employed workers, and are Pareto improving when the benchmark case is a job market without any LETS.

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1. Introduction

Today, there are 4000 alternative local currencies in circulation around the world¹. Each one has particular characteristics. They can be exchanged by a material or an immaterial way, into a network including firms or formed by a group of individuals. Units of complementary currencies can be bought (SOL, Bristol and Brixton Pounds) or created by a mutual exchange of services (LETS). They often allow an extra purchasing power to their users. Users of complementary currency can benefit from a supplementary unit when they purchase it or from some discounts granted by retailers participating. LETS members can benefit from a fixed sum of currency when they enter the system or from a credit when they initiate to purchase into the LETS.

Most of complementary currencies promote social issues. They have generally been created in order to develop local economy and to fight against social exclusion. They permit exchange without official currency without reducing traders to barter. LETS members do not need any banking affiliation. They only have to accept units of complementary currency in payment of goods and services provided to other members. These units have to be spent inside the LETS by the acquisition of other goods and services produced / provided by other members. Thereby, complementary currencies improve the efficiency of informal sector activity.

LETS can thereby attract low income people (especially unemployed and retired people) who want to maintain a minimal level of consumption and preserve or develop skills for future employment. In United Kingdom and in United-States, low-income and unemployed users then became the target audience of complementary currency systems (Seyfang, 2001, 2002, 2003; Collom, 2011; Lasker *et al.*, 2011).

LETS are then useful to fight against social exclusion and to maintain unemployed people at a good level of employability. An open question is however to evaluate their capacity to improve the level of activity. Is this form of organization only able to increase the size of the informal sector and to maintain unemployed workers in a parallel economy, or has it also a real interest for the formal economy as a whole? Do LETS and complementary currencies reduce social exclusion by reducing unemployment, or only by generating a parallel economy? Are they able to enhance welfare? These are the questions that tackle this article.

Local exchange systems are not known for creating jobs directly, which was evidenced by surveys linking LETS and employment (Williams *et al.*, 2001). Except complementary currencies explicitly introduced to provide jobs to unemployed people (Woergl in Tirol

and the Palmas in Brazil), LETS employ mainly volunteers to manage, control and organize the system. If they do not directly create jobs, could they create ones indirectly? It is the issue that we tackle in this paper.

1. Some stylized facts

The stylized facts on which we elaborate in the further sections attest that unemployment spells, especially long ones, cause irreversible damages on unemployed people, like a loss of motivation and a depreciation of skills (Mincer and Ofek, 1982; Pissarides, 1992; Böheim and Taylor, 2002; Edin and Gustavsson, 2007). According to World Bank definition, long-term unemployment refers to the number of people with continuous periods of unemployment extending for a year or longer. Long-term unemployment concerns both developing and developed countries. Indeed, long-term employment represented 52% of the total unemployed workers in 2012, 61% in Ireland, 81% in Montenegro and 39% in Sri Lanka (World Bank Indicators). International Labour Organisation (2014) published a report on "Global Employment Trends" around the world and warned of serious consequences of long-term unemployment. After the 2007-2008 financial crisis in US and the 2010-2012 sovereign debt crisis, especially in advanced countries, the average of unemployment spell has increased, sometimes has doubled. The main issue arising from long-term unemployment is the degradation of specific skills (related to the previous job) which affects the probability of re-employment. In fact, non-participating in the job market increases the risk of skills obsolescence. In addition, longer is the unemployment spell, faster are the loss of specific skills, deteriorating significantly employability and the probability to re-enter the job market. Long-term unemployment is also associated to social issues, such as a decreased life satisfaction and stigmatization (ILO, 2014). Long-term unemployment has a "scarring effect" on unemployed people (Heckman and Borjas, 1980, in Flaig *et al.*, 1993; Mooi Reci, 2008; Cockx and Picchio, 2013). During inactivity, unemployed workers do not exercise their job and cannot maintain or improve their valuable experience and their knowledge. Therefore, their human capital depreciates (Heckman and Borjas, 1980, in Flaig *et al.*, 1993). Unemployed then enter a dynamics whose outcome depends on the path. Those who do not find a job quickly have greater difficulties to find one later (Flaig *et al.*, 1993). The "hysteresis effects" literature points out this human capital depreciation and examines its consequences on labour market interactions. At work, employees increase their productivity by improving everyday their specific skills and experience. When they lose their job, they do not lose immediately their competences. The depreciation of skills accelerates when the unemployment period extends many months and years. Unemployed workers then become less rapid, make mistakes, are less adapted to team work and hierarchical interactions.

Finally, workers improve their employability by learning from themselves or from others at work, by practising team work, from being able to meet the daily

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1According to the French newspaper Libération in May 2014

work schedules. Employability is then a positive function of time spent in activity and its depreciation is positively correlated with unemployment length. (Killingsworth, 1982; Mincer and Ofek, 1982; Desjardins and Warnke, 2012). Employers are thus reluctant to hire long-term unemployed people, due to their human capital depreciation during inactivity spells. They prefer to recruit short-term unemployed, or workers already in job, considered as "more competitive" (Bourdet and Persson, 1991, 1991a).

2. LETS and employability improvement

However, unemployed workers can undertake actions to reduce skill depreciation during an unemployment spell (Johnson and Van Doorn, 1976). They can maintain some level of activity in the informal sector. They can also follow free training sessions, interact with employed workers, or try to stay in touch with a professional environment. LETS offer them advanced opportunities to maintain competences during inactivity spell. Inside LETS, unemployed members increase opportunities to meet a demand for the services they provide. Obviously, members generally prefer to offer services related to their previous job, for which they have competences, rather than to launch a new activity or a secondary activity (Peacock, 2001). Doing that, unemployed people have then the possibility to maintain and actualize their specific skills and, in this way, to improve their employability. Participating in a LETS is similar to self-employment jobs (launching an activity and offering services against remuneration), without the risks related to self-employment activity (no administrative and accounting issues) and with the help of the organizers who are in charge to connect members (Gomez and Helmsing, 2008; Williams *et al.*, 2001). That's in that way LETS can help unemployed workers to re-enter the job market.

But LETS can provide another benefit to their members. Unemployed workers, following the loss of their job, can also lose a part of their social network, which conducts to a loss of a part of professional information like job opportunities (Williams, 1996). Here again, LETS can help unemployed workers to face this problem. By linking members, LETS fights again social exclusion by re-constructing and extending the social network of unemployed people (Williams, 1996; Seyfang, 2001, 2002, 2003; Ozanne, 2010; Lasker *et al.*, 2011). LETS can also improve unemployed employability in another way. Surveys conducted in LETS in UK and in Argentina concluded that LETS encourage the development of self-employment (Williams C.C. *et al.*, 2001; Gomez and Helmsing, 2008). Developing an activity into a LETS provides advantages to members, as developing a client base which will continue to buy those products outside the LETS (Williams C.C. *et al.*, 2001), testing products to evaluate if they are valuable on the formal market (Williams C.C. *et al.*, 2001). A LETS provides also a self-training for the subsequent development of a micro-enterprise (Gomez and Helmsing, 2008). In the survey conducted by Williams C.C. *et al.* (2001), of 810 LETS members respondents, 10.7% explain that "their LETS had helped them become self-employed". And, in the survey

conducted by Gomez and Helmsing (2008), in Clubs de Trueque in Argentina, 78 of 140 respondents tested their activity in the regular economy, of which 40 respondents were still active after one year.

The topic of the following sections is to explore the way a virtual complementary currency can emerge or not into a community of unemployed people. When it emerges, the objective is also to understand by which mechanism this complementary currency – because it improves employability of users – is also able to increase the levels of employment and of welfare of the whole economy.

Thanks to the possibilities offered by the complementary currency in LETS, unemployed workers exchange each other services and goods for an extra income. This is a first property of LETS. To offer these products, they maintain their levels of skills and competences, and particularly the levels of those skills related to their previous jobs (Peacock, 2001). We then assume in this paper that participating in a LETS avoids any loss of skills and productivity during unemployment spell, as pointed out by literature (Mincer and Ofek, 1982; Pissarides, 1992; Böheim and Taylor, 2002; Edin and Gustavsson, 2007) and maintains the level employability of long term unemployed people inside LETS (Flaig *et al.*, 1993). Our main research question is to clarify the influence of LETS on the level of employment.

On order to answer it, we build a benchmark model *à la Diamond* analyzing the transition of workers between three positions on the job market: workers can occupy a job position; they can, also be short-term unemployed workers or finally long term unemployed workers. The dynamics of the model depicts the moves of workers between these three positions according fundamentals of the economy and their own employability. We take stationary equilibrium of this benchmark as the reference position: it corresponds to a position of the economy such that the value of real variables – including the number of employed and unemployed workers – remains unchanged during time. This stationary equilibrium defines a stationary level of unemployment: workers losing their jobs are each period replaced by the same number of newly recruited workers.

With these assumptions, we ask three questions: (i) on which condition such LETS can *survive* or not at stationary equilibrium? (ii) Which is the influence of such LETS on the level of employment?² (iii) What is the effect of LETS on welfare, measured in this case as the average net utility of employed and unemployed workers?

The following sections answer these questions. We first define a benchmark model distinguishing short term and long term unemployment. We introduce a LETS in this model with the property to maintain skills of workers outside employment. We then study the changes in the stationary equilibrium of this job

²As the official statistics of unemployment, the level of unemployment that we consider includes all unemployed workers, inside or outside the LETS

market after the introduction of LETS. The main results of this setting are (i) that trust inside and outside LETS are important determinants of the permanence of LETS (Lemmas 1, 3 and 4), (ii) that when permanent, LETS increase the level of employment (Proposition 1), (iii) that in this case, they improve welfare without generating conflicts of interest (Propositions 2 and 3).

2. The benchmark model

The benchmark model depicts an economy with n workers where the probability to observe employment opportunities decreases during the time each worker remains unemployed. To simplify the setting we suppose that in the economy, workers can take three possible positions:

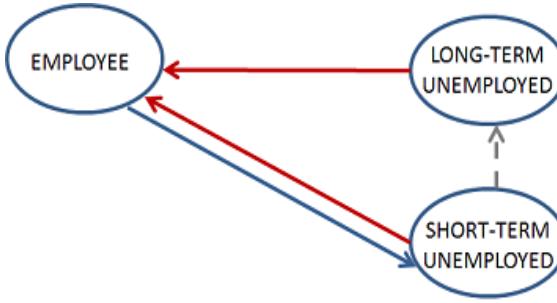
- The employed workers are in proportion e of the total active population. They earn the periodic wage w and have the probability q to lose their job at the end of the period.

Unemployed people distribute in two sub-categories.

- The short-term unemployed workers have been fired during the previous period. They are in proportion s : they receive the unemployment benefit b and have the probability α to find a job during the current period. If they do not observe any opportunity of employment or observe an opportunity and do not obtain the job, they integrate the group of the long-term unemployed workers³.

- The long-term unemployed workers have been fired since more than one period. They are in proportion l . They receive the same unemployment benefit b than the short-term unemployed ones but their probability to observe an opportunity of employment is only α' with $\alpha' < \alpha$ (1).

Figure 1. Transition pattern in the benchmark model



The model is analyzed at stationary equilibrium, which is a state such that (i) the number of employed and unemployed workers remains constant during time, once the environment remains unchanged, and (ii) the expected intertemporal utility a worker occupying a given position is also constant during time. The condition (i) determines stationary amounts of e , s , and l satisfying equations (1), (2) and (3):

$$qe = \alpha s + \alpha' l \quad (1)$$

$$qe = s \quad (2)$$

$$(1 - \alpha)s = \alpha' l \quad (3)$$

with by definition, $e + s + l = 1$. Solving the system gives the equilibrium level of employment $e = \frac{\alpha'}{(1-\alpha)q+\alpha'(1+q)}$. The study of this expression in comparative statics shows that employment increases with the capacity to find a new job in each position of the job market, and with a decrease of the rate of destruction q of existing employment positions. Long term unemployed workers are in proportion $l = \frac{q(1-\alpha)}{q(1-\alpha)+\alpha'(1+q)}$ and short term unemployed ones are in proportion $s = \frac{\alpha'q}{q(1-\alpha)+\alpha'(1+q)}$. A comparative static analysis also shows that their number increases with the increase of the rate of destruction of jobs q , and decreases with an increase of their probabilities α and α' to find a job as short term or long term unemployed workers.

The intertemporal utility associated with each position after consumption is deduced from the Bellman equations (4) to (6):

$$V_e = (1 - q) \frac{w + V_e}{(1 + r)} + q \frac{b + V_s}{(1 + r)} \quad (4)$$

$$V_s = \alpha \frac{w + V_e}{(1 + r)} + (1 - \alpha) \frac{b + V_l}{(1 + r)} \quad (5)$$

$$V_l = \alpha' \frac{w + V_e}{(1 + r)} + (1 - \alpha') \frac{b + V_l}{(1 + r)} \quad (6)$$

where V_e , V_s and V_l figure respectively the intertemporal utilities of an employed worker, a short-term unemployed worker and a long-term unemployed one after consumption, while w and b represent respectively the instantaneous wage of an employed worker and the unemployment benefit of an unemployed worker⁴. The system (4) to (6) also solves and gives the equilibrium values of the intertemporal utility in each position that a worker can occupy on the labor market. The instantaneous components of their utilities are respectively given by the monetary value of wages w and of the unemployment benefit b . Each intertemporal utility is a function of the parameters q , α , α' but also w and b . The study of V_e , V_s and V_l in comparative statics states that (see Appendix 1) each intertemporal utility increases with w , b , α and α' and decreases when q increases. All these relations are intuitive: smaller is the probability of a worker to be fired, greater is his utility in each position of the job market. The same intuition is confirmed concerning the influence of the potentiality to be hired when unemployed on utilities. The other comparative statics properties have also intuitive contents.

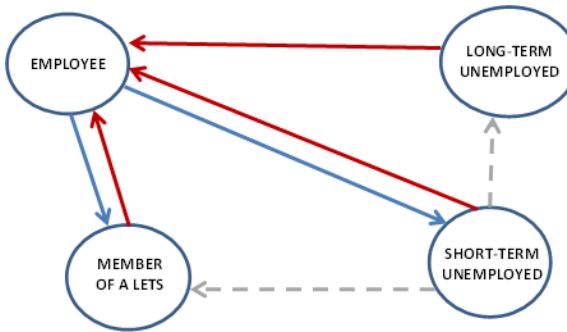
³As work-force is there homogeneous, there is no reason to distinguish here between the cases where no opportunity has been observed and the case where only irrelevant opportunities have been observed.

⁴We suppose as a simplifying assumption that this benefit does not vary with the time each worker remains unemployed. When it decreases during time – which is a reasonable assumption –, the results of the paper are strengthened.

3. Introducing a LETS

A LETS is introduced in this section as a network providing two kinds of services. First, the LETS provides the possibility to exchange informally services among unemployed people, without being limited by the "double coincidence of needs" condition. The complementary currency then increases the efficiency of the informal sector. The instantaneous benefit from being unemployed then increases from b to b' . Second, the LETS maintains the level of skill of unemployed workers and their capacity to face in the job market with an unchanged probability α to be successful at each period⁵. The use of a complementary currency is however nothing but evident for workers more able to accept barter than to trust a private system of intermediation eventually founded on the capacity of other unemployed workers to accept as payment this complementary currency. Outside LETS, workers have heterogeneous levels of confidence in the properties of the complementary currency and in the potentiality of the LETS in general. Suppose as a working assumption that the levels of confidence of employed workers on the reliability of complementary currency are then given by a coefficient λ_i defined on a segment [0,1]. When λ_i is close to 0, worker i has a low level of confidence into the complementary currency; when λ_i is close to 1, this level of confidence is conversely high. With LETS, a fourth position then emerges for workers, besides the three positions analyzed in the benchmark model. It corresponds to the participation to a LETS. The transition process between the four possible positions of the job market is then depicted by Fig (2):

Figure 2. Transition pattern in the model with LETS



With the introduction of the LETS, when an employee loses his/her job, he/she becomes an unemployed worker and faces two possibilities: becoming a "traditional" unemployed worker (namely a short-term unemployed worker) or participating in a LETS. A short-term unemployed worker can also decide to join a LETS before becoming a long-term unemployed worker. When inside a LETS, an unemployed worker

⁵As pointed out by one of the anonymous referees of the *International Journal of Community Currency Research*, one can consider that participation to LETS changes initial skill and adds something else. The structure of this model does not allow to keep it tractable with an heterogeneous workforce. An extension of this work could however consider this property of LETS, with the help of numerical simulations if an analytical treatment is not possible

experiences the complementary currency and its level of confidence evolves upward or downward. This level then evolves from its initial level λ_i to λ with $0 < \lambda \leq 1$. λ reflects the effective properties of the LETS and depends both of the objective reliability of the complementary currency and of the organization of the LETS. As a first approximation, λ will be taken as given⁶.

As there are two possible positions that unemployed workers can occupy outside LETS, there are also two possibilities to join LETS for unemployed people, namely joining them directly just after being fired, or after a first attempt to recover a job as a short term unemployed worker. As it is more valuable to be a short term unemployed worker than a long term one, workers joining LETS directly correspond only to the highest values of λ_i . Those joining them only after a while correspond to smaller values of λ_i as they are only interested in LETS when there have to choose between LETS and the few efficient long-term unemployment worker position. A second consequence can then be deduced from the above assumptions: it is expressed in Lemma 1:

Lemma 1. *If an unemployed worker integrates a LETS with a level of trust λ_i smaller than the level of trust λ of the unemployed workers inside LETS all workers integrating LETS only leave them as employed workers.*

Proof: Consider the worker i such that $\lambda_i < \lambda$. If this worker is a short-term unemployed worker having failed to find a job, his/her choice is between becoming a long term unemployed worker, i.e. having an utility equal to $(1 - \alpha') \frac{b + V_i(\lambda_i)}{(1+r)} + \alpha' \frac{w + V_e(\lambda_i)}{(1+r)}$ and becoming a member of a LETS, i.e., having an utility equal to $V_c(\lambda_i) = (1 - \alpha) \frac{\lambda_i b' + V_c(\lambda_i)}{(1+r)} + \alpha \frac{w + V_e(\lambda_i)}{(1+r)}$. If he/she chooses to integrate a LETS, the second term is greater than the first one. When this same unemployed worker is inside the LETS, his/her intertemporal expected utility is $V_c(\lambda) = (1 - \alpha) \frac{\lambda b' + V_c(\lambda)}{(1+r)} + \alpha \frac{w + V_e(\lambda)}{(1+r)}$ if he/she remains in the LETS and $(1 - \alpha') \frac{b + V_i(\lambda_i)}{(1+r)} + \alpha' \frac{w + V_e(\lambda_i)}{(1+r)}$ if he/she leaves the LETS. It is easy to verify that if $V_c(\lambda_i) = (1 - \alpha) \frac{\lambda_i b' + V_c(\lambda_i)}{(1+r)} + \alpha \frac{w + V_e(\lambda_i)}{(1+r)} > (1 - \alpha') \frac{b + V_i(\lambda_i)}{(1+r)} + \alpha' \frac{w + V_e(\lambda_i)}{(1+r)}$, then $V_c(\lambda) = (1 - \alpha) \frac{\lambda b' + V_c(\lambda)}{(1+r)} + \alpha \frac{w + V_e(\lambda)}{(1+r)} > (1 - \alpha') \frac{b + V_i(\lambda_i)}{(1+r)} + \alpha' \frac{w + V_e(\lambda_i)}{(1+r)}$. When unemployed, the worker i will then never leave the LETS before finding a new job. Suppose then that, in the same situation, agent j is such that $\lambda_j > \lambda$. Then as inside the LETS, the inequality $V_c(\lambda_i) = (1 - \alpha) \frac{\lambda b' + V_c(\lambda)}{(1+r)} + \alpha \frac{w + V_e(\lambda)}{(1+r)} > (1 - \alpha') \frac{b + V_i(\lambda_i)}{(1+r)} + \alpha' \frac{w + V_e(\lambda_i)}{(1+r)}$ also holds for agent j . Agent j then also remains in the LETS until his recruitment ■

Note that if all the agents choosing to join the LETS

⁶In a more complex setting, λ could be made dependent on time and on the members of the LETS.

have a level of confidence in the complementary currency higher than λ , the LETS can emerge or not at equilibrium. Suppose for instance that the agent i with the smallest λ_i choosing to join the LETS is such that λ_i is far greater than λ : in this case, one may have $(\lambda_i b' + V_c(\lambda_i)) < b + V_l$ but also $(\lambda_i b' + V_c(\lambda_i)) > b + V_l$. When we consider the economy out of stationary equilibrium, *i.e.* on a path converging to equilibrium, the size of the LETS change from one period to the other. Suppose that in this case, the agent i with the smallest λ_i choosing to join the LETS is such that λ_i is far greater than λ . In this case, this threshold agent is immediately deceived by the efficiency of the LETS (as he would have been happy to participate to the LETS only if $\lambda \geq \lambda_i$). As unemployed workers only differ by their initial level of trust λ_i and not by their effective level of trust λ when they are in the LETS, all unemployed workers having integrated the LETS will then be deceived too when the worker i is deceived. They will leave the LETS and this last will collapse. The opposite case is when the threshold entrant i is such that $\lambda \geq \lambda_i$. In this case, this threshold agent has the good surprise to observe that the LETS is more safe and efficient than he expected. As all agents are homogenous inside the LETS, all entrants will then remain in the LETS which is in this case sustainable.

Another property on utilities is interesting to prove:

Lemma 2. *When a worker i never chooses to integrate a LETS, his/her intertemporal utility does not depend on his/her level of confidence in the LETS.*

Proof: When the agent i is in this case, its instantaneous utility is given by w when he/she is employed, or b when he/she is unemployed. Accordingly, his/her expected utility never depends on λ_i ■

At last a third interesting property is easy to prove:

Lemma 3. *At stationary equilibrium, all workers (employed or not) devoted to join LETS when unemployed, expect (perfectly) at its level λ the trust of the complementary currency inside the LETS.*

Proof: Suppose that its remains employed workers with a level of trust λ_i such that $\lambda_i \neq \lambda$ and planning to join LETS when fired. Then, the expected utility of these agents as employed workers will move subsequently, once they will have joined LETS. We are then not yet at stationary equilibrium. At stationary equilibrium, all current, past or future participants to the LETS are then the same perfect evaluation λ of the acceptability of the complementary currency ■

With the help of lemmas (1) to (3), the stationary equilibrium of the economy can be deduced.

1. The equilibrium size of the LETS

Like for the benchmark model, the stationary equilibrium is characterized by the stationarity of the population and of the expected intertemporal individual utilities in each position of the job market. Given lemmas 1, 2 and 3, if stationary equilibrium

exists, two distinct subpopulations coexist at equilibrium. The first sub-population gathers workers integrating the LETS when unemployed and expecting perfectly the level of acceptability of the complementary currency / the level of efficiency of the LETS. The second sub-population is characterized by those workers who remain outside LETS when unemployed. Their level of trust in the complementary currency / evaluation of the efficiency of the LETS are heterogeneous but as they do not use LETS. This heterogeneity has no influence of their utility, whatever the position they occupy on the job market. The threshold agent separating the two sub-population is the agent i^* such that λ_i^* is just sufficient to decide him/her to join the LETS if he/she is not recruited directly as a short-term unemployed worker and not leaving this LETS after having observed λ . Knowing λ_i^* is then crucial to determine the size of the two sub-populations. If λ_i^* is close but smaller than λ , the LETS is sustainable and its size given by $(1 - \lambda_i^*)(1 - e^*)$, *i.e.* by the number of unemployed workers having an initial trust in the LETS higher than λ . Obviously, if λ is large but also λ_i^* , the size of the LETS remains small. In other words, if the complementary currency has a good level of acceptability (λ is large) but that the LETS creates few new utility or has few advantages regarding employability (λ_i^* is also large), the LETS remains small and restricted to those agents with a high level of trust before integrating the LETS. In the opposite case, *i.e.* when the advantages of LETS are important regarding utility creation and employability (λ_i^* is small), its equilibrium size is large too. In summary, the level of trust is an important determinant of the size of the LETS but its importance decreases with the fundamental properties of the LETS.

Note that the stationary equilibrium can correspond to cases where the LETS finally collapses. It is the case when λ is very small. In these cases, all unemployed workers integrating initially the LETS finally leave it for the traditional long-run unemployment position. We could consider that this situation becomes realistic if the development of the informal sector in the LETS convinces Government to undertake actions able to cut the unemployment benefits of the members of the LETS or to make the use of complementary currencies illegal. It is also the case if there are more classical crises of confidence with non-reliable management of the complementary currency inside the LETS.

If we concentrate on the cases where the LETS does not collapse, the agent i^* is obtained as the solution of the following equations system of 7 equations. First, the equations determining the expected level of utility of an agent i in each relevant position of the job market when his/her level of trust in the LETS is given by:

$$V_s(\lambda_i) = \alpha \frac{w + V_e(\lambda_i)}{(1+r)} + (1 - \alpha) \frac{\lambda_i b' + V_c(\lambda_i)}{(1+r)} \quad (7)$$

$$V_e(\lambda_i) = (1 - q) \frac{w + V_e(\lambda_i)}{(1 + r)} + q \frac{b + V_s(\lambda_i)}{(1 + r)} \quad (8)$$

$$V_c(\lambda_i) = \alpha \frac{w + V_e(\lambda_i)}{(1 + r)} + (1 - \alpha) \frac{\lambda_i b' + V_c(\lambda_i)}{(1 + r)} \quad (9)$$

Equations (7) to (9) solve in $V_e(\lambda_i)$, $V_s(\lambda_i)$, and $V_c(\lambda_i)$, providing then, as a function of λ_i , the expected intertemporal utility in each position he/she stays, of an agent i planning to integrate a LETS if he is not recruited as a short-term unemployed worker. The following equations (10) to (12) correspond to the expressions of the expected intertemporal utilities for workers preferring not to integrate LETS when they are unemployed.

$$V_s = \alpha \frac{w + V_e}{(1 + r)} + (1 - \alpha) \frac{b + V_l}{(1 + r)} \quad (10)$$

$$V_e = (1 - q) \frac{w + V_e}{(1 + r)} + q \frac{b + V_s}{(1 + r)} \quad (11)$$

$$V_l = \alpha' \frac{w + V_e}{(1 + r)} + (1 - \alpha') \frac{b + V_l}{(1 + r)} \quad (12)$$

Note that equations (10) to (12) replicate exactly the benchmark utility equations (4) to (6) since the situation/utility of workers never joining LETS does not change with the introduction of LETS. Finally, the seventh equation is obtained equalizing expressions of $V_s(\lambda_i)$ obtained as solution of the system (1) to (3) and of V_s solution of the system (4) to (6), as a function of parameters $(w, b, b', q, \alpha, \alpha')$. Lemma 4 summarizes this stage of the resolution of the model:

Lemma 4. *When LETS do not collapse, the proportion of workers integrating LETS when they are unemployed is given by $(1 - \lambda_i^*)$ where λ_i^* expresses as*

$$\lambda_i^* = \frac{b(1+g(-1+\alpha+q-\alpha gq+\alpha' gq))+(-\alpha+\alpha')gw}{b'(1+g(-1+\alpha'+q-\alpha gq+\alpha' gq))} \quad \text{with}$$

$$= \frac{1}{(1+r)}.$$

Proof: see Appendix 2.

One can easily verify that the size of LETS increases with α and decreases with α' , i.e. increases with the decrease of the instantaneous probability to be recruited, for a long term unemployed worker. Comparative statics also shows that this population increases – as predicted by intuition – with $\lambda b'$, i.e., with the performances of the complementary currency and more generally of the organization of the LETS.

2. Effects of complementary currency and LETS on employment and welfare

It is now possible to solve the remaining equations providing the missing conditions to determine the instantaneous size of the LETS at equilibrium, the level of equilibrium employment and the proportion of agents remaining instantaneously outside of LETS as

unemployed workers. These proportions are solution of the system made by equations (13) to (16). Among these five equations, only four are independent and introduced in the resolution system:

$$qe = \alpha s + \alpha c + \alpha' l \quad (13)$$

$$q\lambda_i^* e = s \quad (14)$$

$$(1 - \alpha)s = \alpha' l \quad (15)$$

$$(1 - \lambda_i^*)s = \alpha c \quad (16)$$

with by definition, $e + s + l + c = 1$.

The system solves easily⁷ and provides the stationary proportions of workers, occupying each position (e^*, s^*, l^*, c^*) of the job-market when the stationary equilibrium includes non-empty LETS. These expressions are complex combinations of the parameters but however help to provide the two main results of the paper:

Proposition 1. *When LETS do not collapse, they increase the level of employment.*

Proof: see Appendix 3.

This result interprets easily: as they help workers to find a job easily, LETS increase the supply-side efficiency of the job-market. When workers are unemployed, with the help of the LETS technology (including the complementary currency), long-term unemployed workers maintain their competencies at the same level they had as short-term unemployed workers. Without considering any feed-back from the job-market demand side, the global effect of the LETS is then to enhance the employability of unemployed people and results in a global positive effect on the job-market and on the employment level⁸.

The result of Proposition 1 is strengthened by the following proposition:

Proposition 2. *The intertemporal utility of employed workers increases at stationary equilibrium when there are active LETS.*

Proof: Employed people e associate two sub-populations. The first has the size $\lambda_i^* e$ and gathers all workers who do not integrate LETS when there exist. For this population, the expected intertemporal utility given by V_e is the same than in the benchmark model. The second sub-population has the size $(1 - \lambda_i^*)e$. The expected intertemporal utility of each member of this second sub-population of LETS members or potential members is given by $V_e(\lambda)$, solution of the system (1) to (3) where λ_i is taken equal to λ . After calculations,

⁷with the help of *Mathematica* software as the previous ones.

⁸In another paper, the authors present an analysis of the demand-side effect, in a bi-sectoral model, involving a first-necessity goods sector and a technological goods one. The effect of LETS is founded positive on the demand side of the technological goods sector, negative on the first-necessity (formal) goods sector and ambiguous at the aggregate level (M. Della Peruta and D. Torre, 2012)

$$V_e(\lambda) = \frac{g(b(-1+g-\alpha g)q + (-1+\alpha)b'\alpha\lambda_i q + (-1+q-g(-1+\alpha+q))w)}{(-1+g)(1+g(-1+\alpha+q))},$$

with $g = \frac{1}{(1+r)}$ which is greater than V_e . The expected utility $\lambda_i^*V_e + (1 - \lambda_i^*)V_e(\lambda)$ of employed workers is consequently greater than V_e , the intertemporal utility of employed people in the benchmark model ■

A last proposition proves that there are not conflicts of interest between the members of LETS and the other workers, employed or not, when a part of unemployed workers are members of LETS.

Proposition 3. *When they have no significant influence on the demand of labour, LETS are Pareto-improving when the benchmark is the economy without LETS.*

Proof: For all agents i such that $i < i^*$, the expected intertemporal utility does not change with the introduction of LETS, whatever the position they have on the job market. For the other ones, the utility strictly increases in each position (when we substitute to the “inside LETS” position to the long-term unemployment position). These observations correspond a Pareto-improving situation ■

The organization of LETS and the use of the complementary currency(ies) do not weaken the properties of the traditional unemployment positions and decrease the advantages of those choosing to remain outside LETS when they are unemployed. This is why this result is obtained. If we suppose that the success of the informal sector, boosted by the complementary currency properties, has a negative influence on the demand of labour in the formal sector, then there would be a trade-off between the positive effects of LETS on employment and welfare, as captured by propositions 1, 2 and 3, and their negative effect on the efficiency of the formal sector. Smaller is the substitution between the goods and services circulation in LETS and outside them, or greater is the additional revenue generated in LETS allowing LETS's members to buy goods not available in LETS, greater is the propensity for LETS to have a positive effect on the job-market demand size (Della Peruta and Torre, 2012).

4. Concluding remarks

This paper analyzes the global effects of a social virtual currency circulation between unemployed workers into a community. We elaborate on the following stylized fact: when they integrate a LETS, unemployed workers are able to maintain their skills, to reduce capital depreciation occurring during unemployment spell, and to preserve and extend their social network. These benefits have a positive effect on unemployed workers employability and enable them to re-enter the job market more quickly. We first introduce a

benchmark search-theoretic model with two possible positions for unemployed workers: short term unemployed workers have a higher instantaneous probability to find a job than long term ones. We then introduce LETS having two properties: (i) they improve, because of the use of a complementary currency, the potentiality to buy and sell goods and services in the informal sector, and (ii) they maintain professional skills outside job. With these assumptions, our theoretical model predicts that LETS can emerge or not, maintain or collapse if they emerge, according the initial level of trust inside workers population. When LETS are permanent, we find that if they have no influence on the demand of labour, they increase employment, the level of expected utility of employed workers, and are Pareto-improving when compared to the benchmark case without LETS.

As expressed, confidence on the complementary currency appears to be a necessity for the emergence of LETS. Only workers who have good expectations on the acceptability of complementary currency are able to integrate the LETS. The effective level of trust in the complementary currency inside the LETS is also important. But it is not the only determinant of the success of the LETS. Other determinants are the gain of utility that members can expect from their transactions, and also, in our model focusing on unemployment, the advantages in terms of employability for unemployed workers in the LETS. The policy recommendations resulting from these observations are quite simple. The first condition for LETS survival when they are mainly constituted by unemployed workers is that unemployed workers could find inside the LETS an additional earning (and utility) and overall a possibility to maintain their skills or to develop new ones. There should in this case not be too many legal or fiscal restrictions to their development: their capacity to improve employability, then the level of employment, has to be considered even if they contribute to develop a not fully controlled informal sector. Local authorities can also promote or create these systems, in the context of an adapted regulation, on the basis of the argument concerning social and economic benefits, just like they maintain of unemployed workers' employability (Blanc and Fare, 2012). This is for instance the case of the TEM in Greece, a local currency supporting a LETS network. Local authorities acknowledged economic and social benefits from this system, and proposed that a part of local taxes be paid in TEM.

An out-of equilibrium analysis, founded on numerical simulation could also be interesting to observe the phases of emergence or collapse of LETS. Another extension would be to add demand-side effects generated by LETS on the job-market, *i.e.* the capacity of LETS to increase or not the demand for the goods and services produced by the formal sector.

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Appendix

Appendix 1: The benchmark model

Derivation of e , s , and l :

Equations (1), (2), (3) and identity $e + s + l = 1$ provide (only) 3 independent conditions which allows to find the value of the three variables after solving the system made by three of them. These values are $e = \frac{\alpha'}{\alpha' + q - \alpha q + \alpha' q}$, $s = \frac{\alpha' q}{\alpha' + q - \alpha q + \alpha' q}$, and $l = \frac{q(1-\alpha)}{\alpha' + q - \alpha q + \alpha' q}$.

Derivation of V_e , V_s , and V_l :

Equations (4), (5) and (6) provide 3 independent linear conditions allowing to find the stationary values of V_e , V_s and V_l . These values are:

$$\begin{aligned} V_e &= \frac{bg((-1 + \alpha g - \alpha' g)q + g(-1 + g - \alpha' g + (-1 + g)(-1 + \alpha g - \alpha' g)q)w)}{(-1 + g)(1 + g(-1 + \alpha' + q - \alpha gq + \alpha' gq))} \\ V_s &= \frac{bg(-1 + \alpha + g - \alpha g + g(-1 + \alpha g - \alpha' g)q) + g(\alpha(-1 + g) - \alpha' g)w}{(-1 + g)(1 + g(-1 + \alpha' + q - \alpha gq + \alpha' gq))} \\ V_l &= \frac{bg(-1 + \alpha' + g - \alpha' g + g(-1 + \alpha g - \alpha' g)q) - \alpha' gw}{(-1 + g)(1 + g(-1 + \alpha' + q - \alpha gq + \alpha' gq))} \end{aligned}$$

with $g = \frac{1}{1+r}$.

The comparative static analysis is made after expressing the derivatives of V_e according to q , α and α' .

$$\begin{aligned} \frac{\partial V_e}{\partial q} &= \frac{bg(-1 + \alpha g - \alpha' g) + (-1 + g)g(-1 + \alpha g - \alpha' g)w}{(-1 + g)(1 + g(-1 + \alpha' + q - \alpha gq + \alpha' gq))^2} - \frac{g(1 + (-1 + \alpha')g)(-1 + \alpha g - \alpha' g)(b - w)}{(-1 + g)(1 + g(-1 + \alpha' + q - \alpha gq + \alpha' gq))^2} \\ \frac{\partial V_e}{\partial \alpha} &= \frac{g^2(1 + (-1 + \alpha')g)q(b - w)}{(-1 + g)(1 + g(-1 + \alpha' + q - \alpha gq + \alpha' gq))^2} \\ \frac{\partial V_e}{\partial \alpha'} &= \frac{(-1 + \alpha)g^3q(b - w)}{(-1 + g)(1 + g(-1 + \alpha' + q - \alpha gq + \alpha' gq))^2} \end{aligned}$$

Given the definition values of parameters, the first term is always negative, while the other ones are still positive.

Appendix 2: The model with LETS

Proof of Lemma 4:

Expression of V_e , V_s , and V_l are the same that in Appendix 1. Expression of $V_e(\lambda_i)$, $V_s(\lambda_i)$, and $V_c(\lambda_i)$ are solutions of equations (7) to (9):

$$\begin{aligned} V_e(\lambda_i) &= \frac{g(b(-1 + g - \alpha g)q + (-1 + \alpha)b'\alpha\lambda_i q + (-1 + q - g(-1 + \alpha + q))w)}{(-1 + g)(1 + g(-1 + \alpha + q))} \\ V_s(\lambda_i) &= \frac{g((-1 + \alpha)b'\lambda_i(1 + g(-1 + q)) - \alpha(bgq + w))}{(-1 + g)(1 + g(-1 + \alpha + q))} \\ V_c(\lambda_i) &= \frac{g((-1 + \alpha)b'\lambda_i(1 + g(-1 + q)) - \alpha(bgq + w))}{(-1 + g)(1 + g(-1 + \alpha + q))} \end{aligned}$$

with $g = \frac{1}{1+r}$.

Derivation of λ_i^* : the threshold value λ_i^* of the level of trust of the agent indifferent between integrating a LETS or joining the long-term unemployed worker position is given after equalizing V_s and $V_s(\lambda_i)$:

$$\frac{g((-1 + \alpha)b'\lambda_i(1 + g(-1 + q)) - \alpha(bgq + w))}{(-1 + g)(1 + g(-1 + \alpha + q))} = \frac{bg(-1 + \alpha + g - \alpha g + g + g(-1 + \alpha g - \alpha' g)q) + g(\alpha(-1 + g) - \alpha' g)w}{(-1 + g)(1 + g(-1 + \alpha' + q + \alpha gq + \alpha' gq))}$$

The solution is $\lambda_i^* = \frac{b(1 + g(-1 + \alpha + q - \alpha gq + \alpha' gq)) + (-\alpha + \alpha')gw}{b'(1 + g(-1 + \alpha' + q - \alpha gq + \alpha' gq))}$.

Proof of Proposition 1:

Derivation of e , s , l , and c : These sub-populations are solutions of equations (13) to (16) which provide:

$$\begin{aligned}
e &= -\frac{\alpha' \alpha}{-\alpha'(\alpha + q) + (1 - \alpha)(-\alpha + \alpha')q(b(1 + g(-1 + \alpha + q - \alpha gq + \alpha' gq)) + (-\alpha + \alpha')gw)} \\
s &= \frac{\alpha \alpha' q(\alpha'(1 + g(-1 + \alpha + q - \alpha gq + \alpha' gq)) + (-\alpha + \alpha')gw)}{h + k - p + \alpha} \\
l &= -\frac{(-1 + \alpha)\alpha q(b(-1 - g(-1\alpha + q - \alpha gq + \alpha' gq)) + (\alpha - \alpha')gw)}{b'(1 + g(-1 + \alpha' + q - \alpha gq + \alpha' gq))(-\alpha'(\alpha + q) + ((1 - \alpha)(-\alpha + \alpha')q(b(1 + g(-1 + \alpha + q - \alpha gq + \alpha' gq)) + (-\alpha + \alpha')gw)} \\
c &= \frac{\alpha' q b' g(-1 + \alpha' + q - \alpha gq + \alpha' gq) + b(-1 - g(-1 + \alpha + q - \alpha gq + \alpha' gq)) + (\alpha - \alpha')gw}{h + k - p + \alpha}
\end{aligned}$$

with

$$\begin{aligned}
h &= \alpha^3 gq(b(-1 + gq) + w) \\
k &= \alpha' q(b' + b'g(-1 + \alpha' + q + \alpha' gq) + b(-1 + g - g(1 + \alpha' g)q) - \alpha' gw) \\
p &= \alpha^2 q(b(1 + g(-2 - \alpha' + q + gq + 2\alpha' gq)) + g(\alpha' b' g + w + 2\alpha' w)) \\
\text{and} \\
a &= \alpha(b(1 + g(-1 + q))q + \alpha'^2 g(b' + b'gq + q(bgq + w)) \\
&\quad + \alpha'(bq - b'(-1 + g(1 + q(-1 + gq)))) + gq(b(-2 + q + 2gq) + 2w)))
\end{aligned}$$

A comparison between the values of e in the benchmark model and with LETS shows that, whatever the values of parameters:

$$\frac{\alpha'}{\alpha' + q - \alpha q + \alpha' q} < \frac{\alpha(q(b(-1+g-\alpha g+g(-1+\alpha g)q)+\alpha gw)+\alpha'^2 g(b'+b'gq+q(bgq+w))+\alpha'(bq-b'(-1+g+g(-1+\alpha g)q)+gq(b(-1+\alpha+q-2\alpha gq)-2\alpha w)))}{\alpha' b'(\alpha+q)(1+g(-1+\alpha'+q-\alpha gq+\alpha' gq))}.$$