Reference-Dependent Utility in an Industrial Cluster

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Abstract

This article tries to explain the exceptional levels of knowledge creation in certain industrial clusters, levels that are seemingly higher than what is implied by the usual models of atomistic agents who do not internalize externalities. For this purpose, we introduce reference-dependent utility into an OLG model of an industrial cluster where agents allocate resources between consumption and knowledge investments and where the latter spills over to the rest of the cluster. It is shown that if the agents in the cluster have altruistic preferences, they will internalize the externalities from knowledge investments and create more knowledge than if they were atomistic or considered their neighbors to be rivals.

1 Introduction

A lot of empirical research has demonstrated that knowledge spillovers among firms are a crucial factor for understanding the creation and success of industrial clusters (Porter, 1990; Baptista, 1998). These findings are of course in line with the Marshallian theory of external economies as a cause of geographical agglomeration. However, from a theoretical point of view, given the standard assumptions that individuals are rational and atomistic, it is easily shown that in its attempts to find the optimal allocation of resources, the individual firm or agent will not take into account any external effects on other firms. Even in industrial clusters, the typical result is that public goods will be underprovided from a

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social point of view, i.e. there will be a market failure (Samuelson, 1954; Romer, 1986).

In contrast to this scenario, the literature on successful industrial clusters like the Silicon Valley seems to suggest that market failures have somehow been corrected since the scale of knowledge creation at such locations rather resembles a formidable success than a failure (Saxenian, 1994). If we accept it as a postulate that the most successful industrial clusters have attained a level of knowledge production that exceeds what is 'privately optimal' and have done so largely without outside intervention, how can we explain this correction towards the social optimum?

The literature on externalities includes classics like Coase (1960) who shows how the externality problem might be overcome by bargaining when there are zero transaction costs. However, the Coasian model is probably not easily applicable to tacit knowledge spillovers within an industrial cluster. In the regional economics literature, 'networks' has long been a buzz-word that is used to describe several aspects such as formal and informal transmission of information, flows of goods and services, and sometimes even the social structure of interaction between agents (see for instance Johansson et al, 1994). This approach to analyzing industrial clusters has borrowed a lot from sociologists like Castells (1996) and although the notion of networks is intellectually appealing, it is not easily included in the microeconomic theory of the firm.

There is also an older tradition usually referred to as 'behavioral economics' that proposed that agents were only boundedly rational and that a firm might have several, even conflicting goals apart from profit-maximization (Simon, 1982; for an overview, see McCann, 2001). To a behavioralist, exceptional knowledge creation would not be a theoretical problem; agents in a cluster might simply have wider aims than those related to profits. Behavioralists borrowed insights from psychology but were never really considered to be a part of orthodox regional economics.

However, in recent years behavioralist ideas have experienced something of a revival with the renewed interest in the links between psychology and economic behavior. Utilizing experimental results from social psychology, this tradition is beginning to have a great impact on the way preferences are modelled (for influential overviews see Rabin, 1998, and Starmer, 2000). The inclusion of a reference point/level in the preference function is compatible with and provides an explanation for observed experimental behavior. If, for instance, the reference level is a person's past level of consumption, the loss in utility that arises from falling one unit below the reference level is far higher than the gain of being one unit above the reference level. The difference is greater than what is implied by the usual concave utility function. The phenomenon is referred to as 'loss aversion' and belongs to a class of empirically observed regularities that also includes for instance 'status quo bias' and 'diminishing sensitivity' (Tversky and Kahneman, 1991).

Another aspect that has been shown to influence people's preferences is social status, or as the saying goes concerns about 'keeping up with the Joneses' (Gali, 1994). Agents are not only affected by the absolute level of their own consumption but also of their relative level vis-a-vis other agents. This insight was recognized already by Duesenberry (1949) and has seen a revival in several recent articles (Gali, 1994; Harbaugh, 1996, Carroll et al, 1997). Although intuition suggests that relative consumption should play an important role in industrial clusters, the literature seems largely to have ignored these insights.

In this article, the concept of reference-dependent utility is introduced into a simple 'overlapping-generations' (OLG) model of an industrial cluster. The overall purpose is to analyze whether reference-dependent utility among agents can explain a knowledge production that is higher than the private optimum when agents are atomistic. In the first period, an agent allocates resources optimally between consumption and investing in knowledge that spills over to the rest of the cluster. In the second period, the agent starts a firm and uses his knowledge investments as the main input.

Three types of preferences are modelled; standard atomistic, relativistic (or 'keeping up with the Joneses'), and altruistic. In the relativistic case, a neighbor's second-period levels of consumption enter our agent's utility function as a reference level that he wants to attain. In the spirit of Tversky and Kahneman (1991), the agent has loss aversion in the sense that he only cares about his relative standing when he is below the second-period consumption level of his neighbor with certainty. The agent's incentives for investing in knowledge might thus be weaker than in the atomistic case since some of the knowledge created will be a positive externality benefitting his rival. If, on the other hand, the cluster is characterized by altruism so that our agent is positively affected by the consumption of his neighbor, then knowledge will be produced at an amount closer to the social optimum. The intuition behind these results is that altruistic preferences induce agents to internalize the externalities from their knowledge investments. Hence, clusters with a great deal of social interaction and a 'spirit of community' will create more knowledge than clusters with atomistic or rivaling agents.

In relation to the previous literature, this article makes two specific contributions. First, to the author's knowledge, it is the only attempt so far of integrating relative consumption and reference-dependent utility into a formal model of an industrial cluster. Second, although the model is primarily intended to describe knowledge spillovers within a geographical cluster of firms, the analysis in this article is also relevant for the wider theory of the socially optimal production in the presence of externalities.

The article is structured as follows: In section 2, we outline the basic model that is used in the rest of the paper. In section 3, we present three variations of the model where the only aspect that is altered is the reference level in the utility function. Section 4 discusses the main result whereas the final section concludes the article and offers some proposals for further research.

2 The Model

In order to analyze the effects of reference-dependent utility in an industrial cluster, a standard OLG-model in the spirit of Diamond (1965) and Romer (1986) will be used. Firms in the cluster are assumed to have a given geographical location. Time is discrete and each agent within the cluster lives for two periods; when young and when old. They have perfect foresight and information about the consequences of their own intertemporal choices and of the choices of the other firms in the cluster. In the first period, a particular agent consumes

$$c_1 = \omega - s > 0. \tag{1}$$

The agent's initial resource endowment ω is split between consumption in period 1, c_1, and savings s. The agent always consumes a positive amount in the first period. Savings are used for investments in some factor of production k so that $s = k$. As will be shown below, the production factor k has positive externalities that other producers in the cluster might benefit from. For simplicity, let us think of k as knowledge about a certain production process. During the first period, the agent thus faces a trade-off between consuming and learning.

In the second period, the agent becomes an entrepreneur and starts a small firm. The accumulated knowledge from youth is the single production factor. Firm profits make up total consumption in period 2:

$$c_2 = \Pi = pAk^{\alpha} - rk \tag{2}$$

In the profit function, p is the prevailing price on the world market for the good that is produced. The firm is a price taker that is too small to be able to influence the market price. A is a productivity parameter that reflects the (exogenously given) quality of the cluster environment. r is the marginal cost of production and total costs is a linear function of production scale, represented by k. As usual, there are diminishing returns to the only factor of production k ($\alpha < 1$).

Utility is given by the following general function:

$$U(c_1, c_2, \tilde{c}) = c_1 + \beta[c_2 + \gamma(c_2 - \tilde{c})] \tag{3}$$

The utility of the representative agent thus depends on his levels of consumption c_1 and c_2 but also on a reference level $\tilde{c}$. In the function above, $\beta > 0$ is a time discount factor whereas γ captures the sensitivity of reference level comparisons $(c_2 - \tilde{c})$. As will be shown, γ assumes different values depending on what type of preferences are assumed. The reference level $\tilde{c} > 0$ will reflect a competitor's level of second-period consumption. It is easily shown that in the present setting, the reference level has a negative impact on utility $(\partial U(c_1, c_2, \tilde{c}) / \partial \tilde{c} = -\beta\gamma < 0)$. I will discuss the reference level more thoroughly below.[1] Note that if $\gamma = 0$, we have the standard model $U(c_1, c_2,) = c_1 + \beta c_2$.

Let us assume that apart from the agent discussed above - let's call him m - there is a neighbor called n. Together, m and n make up the industrial cluster.[2] n lives the same kind of life as m and becomes an entrepreneur in the second period, operating in some other market. Consumption in the first period is $c_{1,n} = \omega_n - s_n$ and savings are transformed into knowledge according to $s_n = k_n$.

The key difference between the two is that n one-sidedly benefits from the knowledge investments that m makes. A fraction δk (where $\delta \in (0, 1]$) of the knowledge that m accumulates spills over to his neighbor n (where a $\delta = 1$ would imply that m's knowledge had the character of a pure public good). δ might be thought of as a measure of how close m and n are spatially and/or technologically. Neighbor n therefore has profits and consumption levels in the second period amounting to

$$c_{2,n} = \Pi_n = p_n A (\delta k)^\alpha (k_n)^{1-\alpha} - r_n k_n. \tag{4}$$

The neighbor is a price taker within his market just like m. Both agents share the same cluster environment A and the elasticity of output with respect to m's knowledge k is the same (α). Besides the spillovers from m, n has also accumulated a knowledge stock of his own, namely $k_n > 0$. For simplicity, it is assumed that for some reason, k_n is either irrelevant to m's production or that spillovers are unilateral.

Agent n's utility function is

$$U_n(c_{1,n}, c_{2,n}) = c_{1,n} + \beta c_{2,n} \tag{5}$$

[1] Several other specifications of reference-dependent utility would have been possible, for instance one where both c_1 and c_2 were divided by $\tilde{c}$, as in Duesenberry (1949) and Harbaugh (1996).

[2] Admittedly, an industrial cluster usually consists of more than two agents. n might be thought of as the aggregated group of agents other than m.

where the time preference parameter β is identical to that of m. For simplicity, n does not have relative consumption concerns ($\gamma = 0$).

3 Comparisons

In the section below, we will compare investment decisions in an industrial cluster with knowledge spillovers when agent m has three different kinds of preferences; atomistic, relativistic, and altruistic. The comparisons might equivalently be seen as being made between three clusters with different types of preference structure.

3.1 A Benchmark Case

Agent m is the actor that we are primarily interested in. In the subsections below, we will analyze how optimal decisions about investments in knowledge are affected by variations in m's degree and direction of reference-dependent concerns, i.e. variations in γ and $\tilde{c}$. In the benchmark case below, we will study the conventional behavior of an entrepreneur in a cluster who only cares about his own profits and consumption so that $\gamma = 0$.

Equations (1-3) together with the assumption of $\gamma = 0$ define an optimization problem for m that can be solved by forming the Lagrangian

$$\pounds = c_1 + \beta c_2 + \lambda_1 [\omega - k - c_1] + \lambda_2 [pAk^\alpha - rk - c_2] \tag{6}$$

with the following first-order conditions:

$$\frac{\partial \pounds}{\partial c_1} = 1 - \lambda_1 = 0 \tag{7}$$

$$\frac{\partial \pounds}{\partial c_2} = \beta - \lambda_2 = 0 \tag{8}$$

$$\frac{\partial \pounds}{\partial k} = -\lambda_1 + \lambda_2 \left(p\alpha A k^{\alpha-1} - r \right) = 0 \tag{9}$$

These expressions can be rearranged to form the equilibrium condition:

$$\frac{1}{\beta} = p\alpha A k^{\alpha-1} - r \tag{10}$$

This condition might in turn be used to solve for the optimal level of knowledge investment

$$k^* = \left(\frac{p\alpha\beta A}{1 + r\beta} \right)^{\frac{1}{1-\alpha}}. \tag{11}$$

Simple comparative statics show that investments in knowledge will increase with the market price p, with the quality of the cluster environment A, and with the time preference parameter β, and decrease with the marginal cost of production r. These are non-surprising results.

However, since $\tilde{c} = 0$, agent m has neglected the external effect that the knowledge investment decision has on his neighbor, represented by the parameter δ. From a social planner's point of view, the social welfare function might be described as

$$W = U(c_1, c_2) + U_n(c_{1,n}, c_{2,n}). \tag{12}$$

By maximizing this expression with respect to k in the same manner as above, we can calculate the socially optimal level of knowledge investment by agent m:

$$k^O = \left(\frac{\alpha\beta A p \left(1 + \frac{p_n \delta^\alpha k_n^{1-\alpha}}{p}\right)}{1 + r\beta} \right)^{\frac{1}{1-\alpha}} > k^* \tag{13}$$

As expected, the social planner's optimal level of knowledge is higher than in the private solution. This standard result from the theory of externalities implies a kind of market failure that is sometimes used as an excuse for government intervention. The difference between k^O and k^* increases with the relative price level in the neighbor's market p_n/p, with the strength of externalities δ, and with n's level of knowledge k_n. The intuition is simply that the greater are p_n, δ and k_n, the greater is the increment in the neighbor's marginal utility (and in total social welfare) from an increase in k.

3.2 'Keeping Up With the Joneses'

The results in the benchmark case disregarded reference-dependent utility since it was assumed that $\gamma = 0$. Let us now assume that our representative agent has relativistic concerns in the spirit of Duesenberry (1949), as well as a simple form of loss aversion (Tversky and Kahneman, 1991). More specifically, agent m compares his own level of consumption and profits with that of his neighbor, but only if his own second-period consumption is known to become lower than that of his neighbor. If his own second-period consumption is higher with certainty, he does not make this comparison. Preferences are therefore partly endogenous to the economic situation of our agent. We will henceforth refer to this kind of behavior as 'keeping up with the Joneses'.[3]

[3] We realize of course that the equilibrium level of second-period consumption is actually determined by the structure of the utility function. In the scenario described

The utility function thus becomes

$$U(c_1, c_2, c_{2,n}) = c_1 + \beta [c_2 + \min [0, \gamma (c_2 - c_{2,n})]] \quad (14)$$

implying that $\min [0, \gamma (c_2 - c_{2,n})] = 0$ if $c_2 \geq c_{2,n}$ and $\min [0, \gamma (c_2 - c_{2,n})] = \gamma (c_2 - c_{2,n})$ if $c_2 < c_{2,n}$. The important technical implication of this kind of specification is that agent m's marginal utility of c_2 is higher below the reference level $c_{2,n}$ than above it ($\beta (1 + \gamma)$ as compared to β). The reason is that agent m has loss aversion, i.e. he is sensitive to his neighbor's consumption level only if this level is higher than his own. Thus, one additional unit of consumption makes him happier on the margin when he is below $c_{2,n}$ than when he is above.[4] This assumption captures in a simplified sense the spirit of loss aversion, motivated empirically and formalized by Tversky and Kahneman (1991) as well as by Bowman et al (1999).

Is such a reference-dependent utility specification in line with what is actually observed in industrial clusters? In his often cited book, Porter (1990) describes the ceramic tile industrial cluster in the Italian region Emilia-Romagna. According to Porter (1990, chap 5), the situation in the cluster was one of intense rivalry. The small firms in this industry were often family run and competition was 'intensely personal'. All firms were located close together and the owners knew each other well. Innovations were usually known within days or weeks after they were implemented. Such an atmosphere of rivalry appears to be one example of 'keeping up with the Joneses'-utility, i.e. that agents care a lot about their relative levels of profits or consumption.

Should $c_2 \geq c_{2,n}$ with certainty, then the utility function in (14) will be the same as in the benchmark case. The interesting case is when m is the 'underdog' so that $c_2 < c_{2,n}$. Then the expression for $c_{2,n}$ must be included in the utility function, which means that agent m is forced to take into account the knowledge spillovers that are picked up by his neighbor. Since these knowledge externalities benefit n's level of profits and since $c_{2,n} = \Pi_n$ has a negative impact on m, our agent's incentives for a knowledge investment are weakened as compared to the benchmark case. On the other hand, since the marginal utility of c_2 is higher due to m's loss aversion in the relevant interval, there is a second effect that strengthens incentives for investment.

The usual optimization procedure reveals that m's optimal level of

here, we just take it for granted that the agent knows with certainty in advance whether he will be below or above the reference level.

[4] The utility function will actually display a discontinuous kink at the reference level $c_{2,n}$.

knowledge investment will now be

$$k^{**} = \left(\frac{\alpha\beta Ap \left(1 + \gamma \left(1 - \frac{p_n \delta^{\alpha} k_n^{1-\alpha}}{p}\right)\right)}{1 + r\beta\left(1+\gamma\right)} \right)^{\frac{1}{1-\alpha}}. \tag{15}$$

Whether this expression is larger or smaller than k^* can not be definitely determined but depends on the size of the parameters involved. The strength of spillovers δ plays a key role in this regard. If spillovers are very weak so that δ approaches zero, then the positive effect of reference dependence is likely to dominate, implying a higher k^{**}. However, if δ is relatively high so that $\frac{p_n \delta^{\alpha} k_n^{1-\alpha}}{p} > 1$, then we definitely have that $k^* > k^{**}$. In any circumstance, a certain conclusion is that knowledge investments with 'keeping up with the Joneses'-utility will be below the social optimum and that this type of preferences does not seem to be the explanation for exceptional levels of knowledge investment in clusters.

3.3 Altruism

An alternative assumption is that agent m has altruistic preferences so that he receives positive utility from his neighbor's profits and consumption. In recent years, the empirical literature on industrial clusters has provided numerous observations of social, non-market interactions between firms. Inspired by the sociological literature (for instance Granovetter, 1985), these kinds of informal cooperation have been discussed in terms of social networks and 'embeddedness' (Gordon and McCann, 2000) since they are allegedly difficult to capture by conventional economic theory.

A famous example of the importance of networks is Saxenian's (1994) account of the different performances of the industrial clusters of Silicon Valley in California and Route 128 in the Boston area. Both clusters were made up of firms in the semi-conductor industry and both had nearby access to world-class research universities (Stanford and MIT). Even so, performance started to diverge by the 1970s. Silicon Valley gained the edge and expanded to become the leading region in the world whereas Route 128 experienced a relative decline. Saxenian (1994) and others attribute this divergence to the more successful formal and informal networks in the Silicon Valley. Whereas the typical firm in Silicon Valley was distinctly outward-oriented, drawing upon a rich infrastructure of social relationships, the typical Route 128 firm was relatively hierarchical and inward-oriented and, eventually, less innovative.

A more efficient communication between firms at a given location might of course be modelled as an increase in the spillover parameter δ. However, an important but less recognized effect of intense social interaction in general as well as within an industrial cluster is simply that the agents start to care for each other's well-being, that is they might develop a kind of altruism. Instead of being a bitter rival whose consumption level m wants to beat, n might be regarded as something of a partner in a joint community effort to achieve greater welfare. History and microsociological aspects that are hard to capture in a model are surely very important in this process.

In the model of this article, such an altruism will simply be represented by analyzing a case where $\tilde{c} = -\, c_{2,n}$ at all levels of c_2 so that the utility function becomes:

$$U(c_1, c_2, c_{2,n}) = c_1 + \beta\left[c_2 + \gamma\left(c_2 + c_{2,n}\right)\right] \tag{16}$$

Agent m thus receives utility both from his own consumption c_2 and from the total consumption of all firms in the cluster $(c_2 + c_{2,n})$. The parameter γ measures the strength of this 'community altruism'. Unlike in the case of loss aversion, our agent's preferences are stable and independent of the relation between c_2 and $c_{2,n}$.[5]

This simple switch of sign reverses the result from the previous section so that the parenthesis in the nominator is unambiguously positive. As for knowledge investment, m will now optimally provide at a level

$$k^{***} = \left(\frac{\alpha\beta Ap\left(1 + \gamma\left(1 + \frac{p_n\delta^{\alpha}k_n^{1-\alpha}}{p}\right)\right)}{1 + r\beta\left(1+\gamma\right)}\right)^{\frac{1}{1-\alpha}} \tag{17}$$

which is clearly greater than in the 'keeping up with the Joneses'-case since the difference between the two expressions is that the nominator in (17) is greater than in (15). In order to compare k^{***} with the atomistic k^*, let us first note that $k^{***} = k^*$ if $\gamma = 0$. Hence, by taking the derivative of k^{***} with respect to γ, we will know what level is the higher. The result turns out to be

$$\frac{\partial k^{***}}{\partial \gamma} = \frac{\left(k^{***}\right)^{\frac{\alpha}{1-\alpha}}}{1-\alpha} \cdot \left(\frac{\alpha\beta Ap\left(1 + \frac{p_n\delta^{\alpha}k_n^{1-\alpha}(1+r\beta)}{p}\right)}{\left(1 + r\beta\left(1+\gamma\right)\right)^2}\right) > 0 \quad \forall\gamma \geq 0. \tag{18}$$

The positive sign thus ensures that $k^{***} > k^*$.

If k^{***} is compared with the socially optimal level in the benchmark case in (13), we cannot tell for sure what level will be higher. In any

[5] Note that we do not assume that agent n has an equivalent level of altruism. An equivalent level would imply that altruism in the cluster was strictly reciprocal, i.e. that it had a 'tit-for-tat'-character. We will discuss reciprocal altruism below.

case, we have the result that altruism in the cluster makes our representative agent internalize the positive externalities from knowledge investment and induces him to invest at a level nearer to the social planner's preferred level. This social and 'non-economic' aspect of an industrial cluster is possibly just as important as the prevalence or intensity of spillovers, which is what models of industrial clusters usually focus upon. The sections above have shown that the existence of positive externalities, combined with a 'keeping up with the Joneses'-preference structure with loss aversion, might even lead to a lower level of investment than in the atomistic scenario, whereas altruism leads to a socially more desirable solution, as intuition would suggest.

4 Discussion

In the model above, the reference level $\tilde{c}$ and the strength of reference dependence γ was treated as a variable with three, exogenously imposed variations. Can anything be said about the most realistic characterization of preferences in an industrial cluster and how they emerge?

As was mentioned in the introduction, casual observation of industrial clusters suggests that their firms have managed to overcome the market failure that typically arises when there are positive externalities. Further, they often seem to have done so without much government intervention. In this article, the focus has been on preference-related explanations. However, even when agents have the usual atomistic preferences, it is sometimes argued that an escape from the 'prisoners' dilemma'-like situation of a too low public goods provision might be avoided if we depart from the view of interactions in an industrial cluster as a one-shot game. If we instead consider interactions in the cluster as a repeated, infinite game, it is even rather likely that the players eventually will reach the Pareto optimal solution and stick to that. According to this view, social networks might be understood as the arena where agents share information and possibly agree to collude. This analysis has much in common with seminal contributions such as Coase (1960), Olson's (1965) theory of collective action, and to the newly emerging literature on social capital (see for instance Glaeser et al, 2000).

Although this interpretation of a social network is surely relevant for understanding the success of industrial clusters, this article instead proposes that social networks influence agents' preferences rather than their strategies. The section above showed that if reference-dependent utility among the firm-owners in the cluster is part of an explanation, it cannot be 'keeping up with the Joneses'-utility. The picture of personal rivalry and prestige that for instance emerges from Porter's (1990) description of Emilia-Romagna therefore does not seem to provide a good theoretical explanation to high levels of knowledge investments. Cluster altruism, on the other hand, can indeed provide an explanation to an exceptionally high provision of public goods like knowledge.

In our model, the preference structure was just assumed to be given and nothing was said of how reference-dependent utility might evolve. The standard assumption in economic theory is of course that preferences are stable over time and similar across individuals. Nevertheless, a growing number of economists have come to argue that individual preferences are endogenous to the economic environment in which agents reside. Preferences might even be thought of as a cultural trait that is sometimes genetically inherited but which might just as well, according to this view, be learned in the same way as a language (Bowles, 1998).

Regarding altruistic preferences, it has been argued by evolutionary psychologists that altruism often makes sense from an evolutionary point of view (Wright, 1996). People who help their neighbors tend to receive some help in return when they need it, and hence often stand a better chance of survival than purely egoistic individuals. This type of altruism is generally referred to as 'reciprocal altruism' since it basically works as an agreement: 'As long as you help me, I will help you, and both will gain.' (Trivers, 1971) Altruism of this kind exists mainly because it is practical for both parties, not because agents share any deeper sympathy for each other.

In the model above, we did not make any assumption of n being altruistic. Reciprocal altruism probably often emerges within industrial clusters as a result of repeated interaction. But this kind of preference abstracts from emotional aspects like sympathy and friendship. Studies of industrial clusters sometimes show that agents appear to share a 'sense of belonging' or 'spirit of community' that goes beyond pure reciprocal altruism. Such feelings might arise as agents participate in social networks and associations that are basically non-economic in character like churches, sports clubs, or town assemblies. The cultural and historical heritage usually play an important role as well. Factors such as these might partly explain how genuinely altruistic preferences might emerge in industrial clusters that, in turn, induce agents to overcome the tendency towards market failure in the presence of externalities.

5 Conclusions

By introducing reference-dependent utility in a model of an industrial cluster with externalities from knowledge investments, it is shown that knowledge will be underprovided if neighbors are seen as rivals whereas knowledge will be provided near the socially optimal amount if a representative agent is altruistic. In the latter case, our agent internalizes the externalities from knowledge investment. The model offers an empirically plausible explanation to the issue of how agents in an industrial cluster manage to overcome the problem of too low knowledge provision without any intervention from outside.

Cluster rivalry or altruism enter the model as different assumptions and it is not explained how either preference structure evolves. A possible field of future research might be to model the strength of altruism as a stock that depends on time, social homogeneity, external threats, and similar factors.

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