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Phone: 0040-264-41.86.52, oeconomica@econ.ubbcluj.ro, http://studiaoeconomica.reviste.ubbcluj.ro/

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# EXISTENCE AND EFFICIENCY OF STATIONARY STATES IN A RENEWABLE RESOURCE BASED OLG MODEL WITH DIFFERENT HARVEST COSTS

**Karl FARMER**[*]
University of Graz, Graz, Austria

**Birgit BEDNAR-FRIEDL**
University of Graz, Graz, Austria

**Abstract:** In a renewable resource based overlapping generations (OLG) model without harvest costs, a complex combination of the time discount factor, the resource production share, and the natural regeneration rate ensure the existence of a stationary market equilibrium and its intergenerational efficiency when the own rate of return on natural capital is positive. This paper investigates to what extent previous findings carry over to an OLG economy with two types of unit harvest costs (constant, inverse stock dependent) arising from the competition for labor between resource harvesting and resource processing. In contrast to the model without harvest cost, we show why large unit harvest costs, surprisingly, do not require a complex combination of basic parameters for the existence of a stationary state, and that in the model with stock dependent costs intergenerational efficiency might occur even when the own rate of return on natural capital is negative.

**JEL classification**: C62; D90; Q20

**Keywords**: Renewable resources, harvest costs, overlapping generations, existence, intergenerational efficiency

## 1. Introduction

There is no such thing as free lunch - or in the context of natural resources, harvesting involves effort which translates into costs in terms of time and/or money. For any renewable resource, harvest costs can be constant, depend on the harvest

[*] Corresponding author. Address: Institute of Economics, University of Graz, Universitätsstraße 15, A-8010 Graz, Austria, phone: +43 316 380-7113, E-mail: karl.farmer@uni-graz.at

volume or on the resource stock (Bjørndal et al., 1993; Grafton et al., 2007). Constant harvest costs characterize a resource which is difficult to access but once access is achieved harvesting leads to no additional costs.[1] In real world situations, constant harvest costs are hardly found for renewable resources, but it is a common (implicit) modeling assumption because it seems to be merely a generalization of the case without harvest cost (Smith, 1968). Harvest costs that depend on the harvest volume are typical for many renewable resources which are available in abundance, such as aquaculture or wood (Smith,1968; Heaps and Neher, 1979). Finally, harvesting effort and hence costs can also depend on the resource stock following the general wisdom `the larger the stock, the easier to catch.′ (Clark and Munro, 1975)

While the importance of harvest costs is fully acknowledged in partial equilibrium models of resource dynamics (Clark and Munro, 1975; Levhari et al., 1981; Olson and Roy, 1996), harvest costs of any types are hardly found in dynamic general equilibrium models (exemptions being: Krutilla and Reuveny, 2004; Elíasson and Turnosvsky, 2004; Bednar-Friedl and Farmer, 2013).[2] In contrast to partial equilibrium resource dynamic models, in dynamic general equilibrium models with interdependent factor and product markets as well as asset markets the existence of stationary (steady) states cannot be taken for granted, in particular in dynamic general equilibrium models of the overlapping generations (OLG) type.[3] In fact, in a renewable resource based OLG model without harvest costs a complex combination of the time discount factor of households, the resource production share of firms, and the natural regeneration rate is needed to ensure the existence of stationary market equilibrium (Mourmouras, 1991; Farmer, 2000; Koskela et al., 2002). Moreover, in OLG models without harvest costs only those stationary market equilibrium solutions are intergenerationally efficient where the own rate of return on natural capital is positive (Koskela et al., 2002).

The goal of this paper is therefore to investigate to what extent the conditions for the existence and intergenerational efficiency of stationary market equilibria in the model without harvest cost carry over to OLG models with harvest costs. In this OLG economy, harvest costs arise from the competition for labor between resource harvesting and resource processing, and unit harvest costs can either be constant or depend inversely on the resource stock. Based on partial equilibrium resource dynamics insight, one might presume that the magnitude of the harvest costs parameter is instrumental for the question whether the rather demanding existence

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1 Yet, fixed costs can occur in addition to operating costs (see e.g. Smith, 1968). An example for fixed costs are investment costs for harvesting equipment, such as for the fishing fleet in fisheries or harvesting machines and access roads in forestry.

2 Although probably to the surprise of the general economic reader, there is to the best of our knowledge not any recent literature on different types of harvest costs in renewable resource based OLG models.

3 The advantage of an OLG model as compared to Ramsey-type growth models with infinitely lived agents (ILA) or a benevolent social planner is that the OLG framework is better capable to capture the finite lifetime of households versus the infinite lifetime of natural resources and the consequences for resource harvest and conservation when the resource stock serves as store of value across adjacent generations (e.g. Howarth and Norgaard, 1990; Mourmouras, 1991; Olson and Knapp, 1997; Krautkraemer and Batina, 1999; Koskela et al., 2002; Valente, 2008; Bréchet and Lamprecht, 2011; Bednar-Friedl and Farmer, 2013).

conditions obtained for the no-harvest cost case hold also under harvest costs. In this paper we therefore analyze whether the existence conditions, which are necessary for the no-harvest costs case, are required also for the case with harvest costs, how the magnitude of the harvest cost parameter might change this conditions, and whether there is a difference between constant and inversely stock dependent unit harvest costs.

It is well known for OLG models in general that a stationary-state market equilibrium can be intergenerationally inefficient because of the double infinity of goods and agents (Shell, 1971). Redistribution of savings and hence consumption between the young and old generation could lead to a Pareto improvement (de la Croix and Michel, 2002). In case of a renewable resource based economy, an inefficient stationary-state market equilibrium corresponds to a case where the opportunity costs of holding the resource stock are negative - a situation which would imply a negative own rate of return on assets (Koskela et al., 2002). Assuming constant or inversely stock dependent harvest costs, we therefore investigate the range of the harvest costs parameter on which intergenerational efficiency respectively inefficiency occurs. Since to the best of our knowledge intergenerational efficiency in an OLG economy with harvest costs is not investigated at all in the literature, in the second part of the paper we derive the necessary conditions for a stationary intergenerationally efficient allocation under both types of harvest costs and then explore under which conditions stationary market equilibrium allocations are intergenerationally efficient.

This paper demonstrates that the incorporation of harvest costs, and in particular whether harvest costs depend only on the harvest level or also inversely on the resource stock, has profound implications for the existence and intergenerational efficiency of stationary state solutions in the OLG framework.[4] Regarding existence, we find that the existence conditions, which are necessary for the no-harvest costs case, are required also for the case with harvest costs, but only when unit harvest costs are comparatively small. When unit harvest costs are however large, the restrictions on basic model parameters (besides the harvest cost parameter) are no longer required. Since this result is at first sight surprising, we will also show why this is the case. Moreover, we find that only a subset of all biologically feasible resource stocks is economically feasible in the model with harvest costs while no such restriction applies in the model without harvest costs. In order to ensure positive (economically feasible) resource stock prices in general equilibrium, the harvest price has to be larger than the marginal harvest costs. We show on which subsets of biologically feasible resource stocks the resource stock price is indeed positive.

Regarding intergenerational efficiency, the main second insight of this paper is that not only the magnitude of the harvest cost parameter, but also the type of harvest costs, matters for the intergenerational efficiency of the stationary state. While under constant unit harvest costs stationary market equilibrium allocations are intergenerationally efficient for a positive own rate of return on the resource stock (as under no harvest), this is not the case for inversely stock dependent unit harvest costs. In particular, it turns out that the stationary market equilibrium can be intergenerationally efficient even when the own rate of return on natural capital is negative.

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[4] Comparative dynamics subject to economic and biological shocks is beyond the scope of the present paper. For the analysis of the steady state effects of those shocks in a comparable deterministic OLG model see Bednar-Friedl and Farmer (2013) and in a stochastic environment Kennedy and Barbier (2015).

There are thus two main contributions of this paper to the literature on renewable resource based OLG models still succinctly represented by Koskela et al.'s (2002) canonical resource dynamical general equilibrium model without harvest costs. First, in addition to and as the former authors we perform a thorough mathematical analysis of the existence, uniqueness and dynamical stability of stationary market equilibria both for constant and inverse stock-dependent unit harvest costs albeit for the special case of log-linear utility and Cobb-Douglas production functions. Second, also in addition to Koskela et al.'s (2002) intergenerational efficiency analysis without harvest costs we compare extensively the stationary market equilibrium solution under both harvest costs types to the corresponding intergenerational efficiency planer solutions.

The remainder of the paper is structured as follows. Section 2 provides the description of the model, including a characterization of the different types of harvest costs. Section 3 derives the conditions for the existence, uniqueness and asymptotic stability of a nontrivial stationary state for each type of harvest costs. The intergenerational efficiency of these solutions is analyzed and compared in section 4. Section 5 discusses our results and concludes.

## 2. Model description

This chapter provides a concise description of the general modeling framework which consists of a standard (Diamond, 1965)-type OLG model with a renewable resource stock with concave regeneration and different types of harvest cost function. The basic model without harvest costs is closely related to the special case of log-linear utility and Cobb-Douglas technology in Koskela et al. (2002). Into this model we introduce two types of resource harvest cost by assuming that harvesting competes with resource processing for labor and that the costs of harvesting are borne by the younger generation as the resource owner (as in Bednar-Friedl and Farmer, 2013). The renewable resource is used as input in resource processing.

### 2.1. Household and firm optimization

To be able to analytically elaborate the consequences of different types of harvest cost, we assume log-linear utility and Cobb-Douglas technology and logistic resource growth.[5] Moreover, we assume that the renewable resource is the only store of value.[6]

The representative consumer's intertemporal utility depends on consumption during the working period, $C_t^1$, and consumption during the retirement period, $C_{t+1}^2$:[7]

[5] As shown by Lloyd-Braga et al. (2007), more general utility functions generate multiple steady state solutions which we want to avoid in order to be able to focus on the existence and intergenerational efficiency implications of different types of harvest cost.

[6] In contrast to a model with a renewable resource stock and physical capital as in Bednar-Friedl and Farmer (2013), abstracting from physical capital keeps the analysis more tractable, i.e. the analysis of existence, stability and efficiency can be performed without having to resort to numerical analysis. At the same time, the general insights from this simpler model are quite similar to the case with two stocks.

[7] Because population is normalized to one, $C_t^1$ and $C_{t+1}^2$ are either per-capita consumption or aggregate consumption in the working and retirement period, respectively.

The representative young household's preferences are represented by a log-linear intertemporal utility function:

$$u = u(C_t^1, C_{t+1}^2) = \ln C_t^1 + \beta \ln C_{t+1}^2 , \tag{1}$$

with $0 < \beta < 1$ denoting the old-age utility discount factor.

When young the household splits her working time (normalized to one) between employment in the production sector and resource harvesting effort $h$. The young household thus gains wage income and revenues from selling the resource harvest $X_t$.[8] These revenues are spent on consumption $C_t^1$ and acquisition of the renewable resource stock $R_t^d$ for transferring income to their retirement period. The resource stock $R_t^d$ is bought from the older household in a competitive market at the beginning of the period.[9]

The budget constraint in the working period is thus:

$$p_t R_t^d + C_t^1 = w_t(1 - h(R_t^d)X_t) + q_t X_t , \tag{2}$$

where $w_t$ denotes real wage, $q_t$ the price of resource harvest, $p_t$ the price of the resource stock demanded, and the consumption good in period $t$ serves as the numeraire.

The old household gains revenues from selling the resource stock in the retirement period, which is spent on consumption $C_{t+1}^2$:

$$C_{t+1}^2 = p_{t+1} R_{t+1} . \tag{3}$$

The resource stock evolves according to:

$$R_{t+1} = R_t^d + g(R_t^d) - X_t , \tag{4}$$

where $g(R_t^d)$ denotes the concave resource regeneration function which is specified as logistic:[10] $g(R_t^d) = r[R_t^d - (R_t^d)^2 / R_{\max}]$, where $r > 0$ denotes the regeneration rate and $R_{\max}$ the carrying capacity.

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8 This assumption is very similar to the one used by Elíasson and Turnovsky (2004) in an endogenous growth model of the ILA type in which they assume that labor is allocated between a resource extraction and a processing sector.

9 As a consequence of exclusive private property rights (as for e.g. a fish pond or a fishing ground), the younger household acquires the resource stock from the older household in the competitive resource stock market at the beginning of the period and can also appropriate the revenues from resource harvest in the current market period. In contrast to this beginning-of-period market equilibrium notion, (Koskela et al., 2002) use the end-of-period asset market equilibrium concept.

10 This is the standard assumption in OLG models with a renewable resource (see e.g. Krautkraemer and Batina, 1999; Farmer, 2000; Koskela et al. 2002; Bednar-Friedl and Farmer, 2013).

Finally, the unit harvest cost function $h(R_t^d)$ is assumed to have the following properties: $h'(R_t^d) \leq 0$. Throughout the paper, three different versions of unit harvest cost functions will be used representing the idea that resource harvest requires labor (or effort) as input (Krutilla and Reuveny, 2004; Elíasson and Turnovsky, 2004).

In case of constant unit harvest cost, we have:[11]

$$h(R_t^d) = \lambda, \lambda > 0 . \tag{5}$$

Alternatively, we will assume that unit harvest costs are inversely related to the resource stock:[12]

$$h(R_t^d) = \frac{\lambda}{R_t^d}, \tag{6}$$

yielding a total cost function which is linear in the harvest volume and inversely stock dependent: $h(R_t^d)X_t = (\lambda X_t)/R_t^d$. As a benchmark to which we compare the two types of harvest costs, we will also analyze the case of no harvest costs: $h(R_t^d) = 0$.

The representative household thus chooses $C_t^1$, $C_{t+1}^2$, $R_t^d$, and $X_t$ to maximize (1) taking account of (2)-(6). This yields the following first order condition for intertemporal consumption decisions:

$$\frac{C_{t+1}^2}{\beta C_t^1} = \frac{[1 + g'(R_t^d)]p_{t+1}}{p_t + w_t h'(R_t^d)X_t} . \tag{7}$$

Eq. (7) thus requires that the intertemporal marginal rate of substitution between consumption when young and consumption when old equals the net return factor on the resource stock.

The second condition equates the price of the resource stock to the net return on resource harvest:

$$p_t = [q_t - w_t h(R_t^d)][1 + g'(R_t^d)] - w_t h'(R_t^d)X_t . \tag{8}$$

For the case without harvest cost ($h(R_t^d) = 0$),(8) simplifies to $p_t = q_t[1 + g'(R_t^d)]$, i.e. the resource stock price has to be equal to the harvest price taking account of resource regeneration in the respective period. With linear harvest costs, the revenue from selling the resource harvest is reduced by the costs involved in harvesting ($w_t h(R_t^d)$). If harvesting effort depends additionally on the resource

[11] In line with basic economic reasoning, we could also assume that total harvest costs are not linear but quadratic in the harvest level. While the analysis turns out much more complicated, the qualitative results are similar as in the case of linear harvest cost.

[12] Multiplying the right hand side of (6) by $X_t$ gives total harvest costs. Solving this expression for $X_t$ yields the well-known Schaefer (1954) harvest function, a functional specification popular in mostly (partial) equilibrium fishery models (Clark, 1990; Conrad, 1999; Brown, 2000; Maroto et al., 2012).

stock, then the revenues on harvesting are increased by keeping an additional unit unharvested (because of $h'(R_t^d) < 0$).

The firm is assumed to behave competitively and to maximize profits given output and input prices. The output of resource processing is described by a constant-returns-to-scale Cobb-Douglas production function with labor $N_t^d$ and resource harvest $X_t$ as inputs: $Y_t = (X_t^d)^{\alpha}(N_t^d)^{1-\alpha}$. The firm's first order conditions read as follows:

$$q_t X_t^d = \alpha Y_t,\ w_t N_t^d = (1-\alpha)Y_t. \tag{9}$$

All markets are assumed to clear every period, i.e. the markets for the resource stock ($R_t^d = R_t, \forall t$), for resource harvest ($X_t^d = X_t, \forall t$), and for labor ($N_t^d = 1 - h(R_t)X_t, \forall t$). Finally, market clearing for the output of the resource processing sector coincides with Walras' Law and is therefore redundant:

$$(X_t)^{\alpha}[1-h(R_t)X_t]^{(1-\alpha)} = C_t^1 + C_t^2, \tag{10}$$

where

$$C_t^1 = \gamma\{w_t[1-h(R_t)(\Phi(R_t)R_t + X_t)] + q_t\Phi(R_t)R_t\}, \tag{11}$$

$$C_t^2 = [1+g'(R_t)][q_t - h(R_t)X_t]R_t + w_t h(R_t)X_t, \tag{12}$$

and where $\gamma \equiv 1/(1+\beta)$, and $\Phi(R_t) \equiv g(R_t)/R_t - g'(R_t)$ being the resource rent.

### 2.2. The stationary state market equilibrium

As in Koskela et al.'s (2002) model with log-linear utility function and Cobb-Douglas technology, the intertemporal equilibrium dynamics can be reduced to a one-dimensional system in $R_t$. By using household's and firm's first order conditions (1)-(6) in the goods market clearing condition (10), setting $X_{t+1} = X_t = X, \forall t$ and $R_{t+1} = R_t = R, \forall t$, and acknowledging that according to (4) $X = g(R)$ the following stationary state relationship is obtained:

$$\Psi(R) = \frac{g(R)\{[1-\gamma(1-\alpha)]R - [h(R)R - (1-\gamma)(1-\alpha)h'(R)R^2]g(R)\}}{R[a - h(R)g(R)]}, \tag{13}$$

where $\Psi(R) \equiv \{\gamma\Phi(R) + [1+g'(R)]\}R$. In the following, we will denote the left hand side of (13), in case of no harvest cost, by $\mathrm{LHS0}(R)$ and the right hand side by $\mathrm{RHS0}(R)$ (see Figs. 1-2). For linear harvest cost, they will be denoted by $\mathrm{LHSL}(R)$ and $\mathrm{RHSL}(R)$ (see Figs. 3-4) and for inversely stock dependent by $\mathrm{LHSR}(R)$ and $\mathrm{RHSR}(R)$ (see Figs. 5-6).

Inspecting the denominator of (13) reveals that this function can exhibit a pole when $[\alpha - h(R)g(R)] = 0$. Evidently this cannot occur in the model version without harvest cost because then $h(R) = 0$. For the model with linear harvest cost, two poles can emerge (see Fig. 4). In contrast, in the model with inversely stock dependent harvest cost, only one pole emerges (see Fig. 6). As a consequence of the emergence of poles, Proposition 1 thus states that without harvest costs all biologically feasible resource stock values ($0 < R < R_{\max}$) are also economically feasible while with constant or inversely stock dependent harvest cost only a subset of all biologically feasible resource stocks is also economically feasible.

**Proposition 1 (Economic feasibility)**

Without harvest cost, all resource stocks $R \in (0, R_{\max})$ are economically feasible. With linear harvest costs, for $\lambda r R_{\max} - 4\alpha < 0$ all resource stocks $R \in (0, R_{\max})$ are economically feasible while for $\lambda r R_{\max} - 4\alpha > 0$ all resource stocks $R \in (0, \hat{R}_1) \cup (\hat{R}_2, R_{\max})$ are economically feasible, and for $\lambda r R_{\max} - 4\alpha = 0$ all resource stocks $R \in (\hat{R}_2, R_{\max})$ are economically feasible. With inversely stock dependent harvest cost, for $\lambda \leq \alpha / r$ all resource stocks $R \in (0, R_{\max})$ are economically feasible while for $\lambda > \alpha / r$ all resource stocks $R \in (\hat{R}_2, R_{\max})$ are economically feasible.

**Proof 1:** See Appendix A.1.

According to Proposition 1, constant unit harvest costs with a sufficiently large harvest cost parameter lead to two ranges of economically feasible resource stocks: to the left of the smaller pole $\hat{R}_1$ and to the right of the larger pole $\hat{R}_2$. Between these poles the resource stock price, which equals the difference between the price of the harvest and the marginal harvest cost, becomes negative precluding an economically feasible stationary state solution (see gray shaded area in Fig. 4).[13] The reason for the economic infeasibility of intermediate values of the resource stock is that, due to logistic regeneration, the harvest volumes are highest for intermediate values of the resource stock and that therefore associated total harvesting effort, $\lambda X$, exceeds the production share of harvest input $\alpha$.

In contrast, with stock dependent harvest cost, and a sufficiently large harvest cost parameter, economically feasible resource stock values are only found to the right of the only pole $\hat{R}_2$ (the gray shaded area in Fig. 6 indicates again the range of economic infeasibility). Thus, while for linear harvest cost both small and large resource stocks are feasible (but not intermediate sized ones), only large resource stock values are feasible with inversely stock dependent harvest costs. This finding can be attributed to marginal harvest costs: because they are decreasing in the latter

[13] To see that, we evaluate (8): $p = [q - wh(R)][1 + g'(R)] - wh'(R)g(R)$. A sufficient condition for $p > 0$ is that $q - wh(R) > 0$. After substituting for the firm's first order conditions, this condition is equivalent to $\alpha[1 - h(R)X] > (1 - \alpha)h(R)X \Leftrightarrow \alpha > h(R)X = \lambda g(R)$.

case but constant in the former, stock dependent harvest costs push the economically feasible resource stock range upwards. Or in other words: for a high harvest cost parameter, the (discounted) market price of the resource stock, which is the difference between the market price of the resource harvest and wage-dependent harvest costs, is negative for some smaller resource stock values: $q - wh(R) < 0 \Leftrightarrow \alpha < \lambda g(R)/R$. The reason for that finding is that the total harvesting effort – which now equals the fixed harvest cost parameter multiplied by average resource productivity – are largest for small values of the resource stock.

## 3. Existence of stationary state market equilibrium

Having established that the whole range of biologically feasible resource stock values, i.e. $R \in (0, R_{\max})$ is also economically feasible in the model without harvest costs but not in the model variants with harvest costs, we now investigate the existence, uniqueness and asymptotic stability of the stationary state resource stock for that case.

### 3.1. Reference model without harvest cost

For a nontrivial stationary state to exist and to be asymptotically stable, it is sufficient that the left hand side of (13), denoted by $\mathrm{LHS0}(R)$, cuts the right hand side, $\mathrm{RHS0}(R)$, from below at the intersection point.

As summarized in Proposition 2, this is essentially the case if the slope of the left hand side at the origin is flatter than the slope of the right hand side.

**Proposition 2 (Existence, uniqueness, and stability without harvest cost)**
For $h(R) = 0$ a unique and asymptotically stable nontrivial stationary state solution $R \in (0, R_{\max})$ with $p > 0$ exists if $1 - (1-\gamma)r > 0$ and $\lim_{R->0^+} \mathrm{LHS0}'(R)$ $\lim_{R->0^+} \mathrm{RHS0}'(R) \Leftrightarrow \alpha(1+r) < [1-\gamma(1-\alpha)]r$.

**Proof 2:** See Appendix A.2.

According to Proposition 2, two conditions are sufficient for the existence of a stationary state market equilibrium. For being able to apply the intermediate value theorem, we need to ensure that at $R = R_{\max}$ $\mathrm{RHS0}(R) > \mathrm{LHS0}(R)$ and that the opposite holds at the origin. Since $\mathrm{RHS0}(R) = 0$ at $R = R_{\max}$, it is necessary that $\mathrm{LHS0}(R) > 0$ at $R = R_{\max}$ which leads to the first condition: $1 - (1-\gamma)r > 0$. Moreover, since $\mathrm{LHS0}(0) = \mathrm{RHS0}(0) = 0$ at the origin, it is required that the slope of $\mathrm{LHS0}(R)$ in the neighborhood of the origin is smaller than the slope of $\mathrm{RHS0}(R)$ or equivalently that $\alpha(1+r) < [1-\gamma(1-\alpha)]r$ .The economic intuition for the first condition is that the aggregate of young and old household consumption has to be positive at $R_{\max}$, and hence also for all other resource stock values (see eqs. (11)-(12) above). The second condition requires that the additional output generated by a marginal increase in resource input due to a marginal increase of the resource

stock has to be met by intertemporal household savings sufficiently large to allow for that increased use of the resource stock in resource processing. Note that this condition is rather similar to the constraint on capital use in an OLG model with physical capital as the only asset (for the corresponding condition, see Galor and Ryder (1989)).

Figures 1-2 illustrate the stationary state market solution which, depending on parameter values, either lies to the left of the maximum sustainable yield resource stock, $R_{MSY} = R_{\max}/2$ (Fig. 1), or to the right of it (Fig. 2).[14]

**Fig. 1. A unique and asymptotically stable stationary state $R < R_{MSY}$ in model without harvest cost**

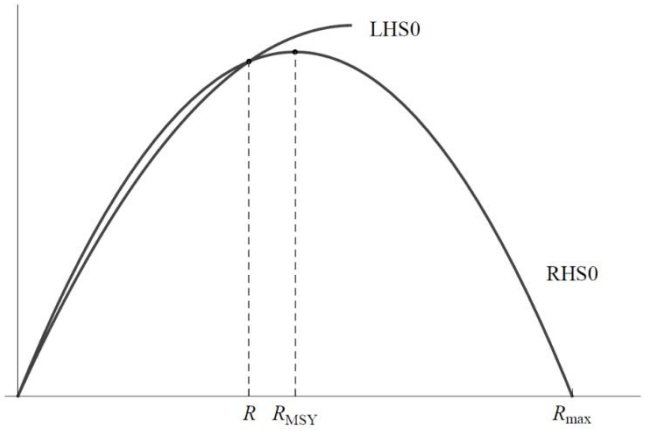
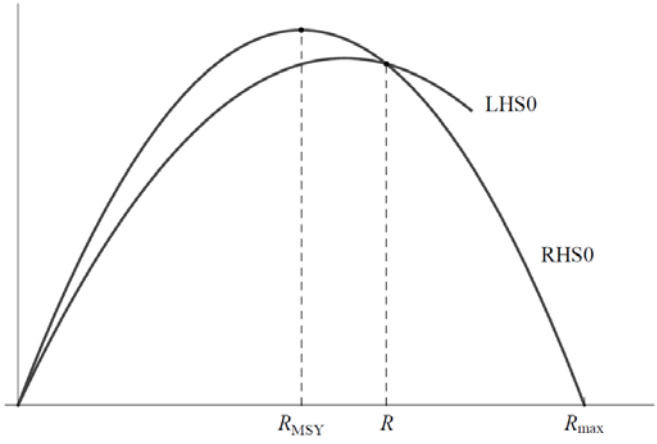



**Fig. 2. A unique and asymptotically stable stationary state $R > R_{MSY}$ in model without harvest cost**




[14] The figures are drawn for illustrative purposes based on the following parameter set: $\alpha = 0.3, r = 1.4, R_{\max} = 10, \lambda = 0$. In Fig. 1, $\beta = 0.6$, while $\beta = 0.9$ in Fig. **2**.

### 3.2. Model with constant unit harvest cost

For constant unit harvest cost, economic feasibility may be violated over some ranges of biologically feasible resource stock values. Thus, we need to distinguish two cases for the existence of an asymptotically stable stationary state resource stock.

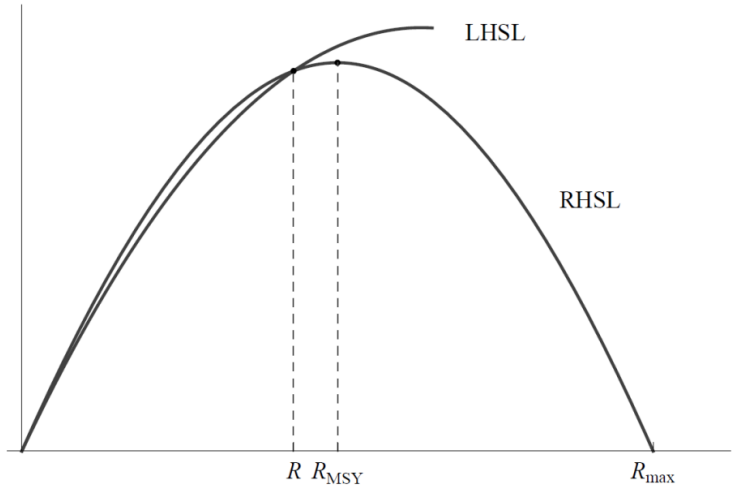
**Proposition 3 (Existence, uniqueness, and stability with constant unit harvest cost)**

For $h(R) = \lambda$, a unique and asymptotically stable nontrivial stationary state solution with $p > 0$ exists if $\lambda < (4\alpha)/(rR_{\max}), 1-(1-\gamma)r > 0$, and moreover $(1+r)\alpha < [1-\gamma(1-\alpha)]r$, or if $\lambda \geq (4\alpha)/(rR_{\max})$.

**Proof 2:** See Appendix A.2.

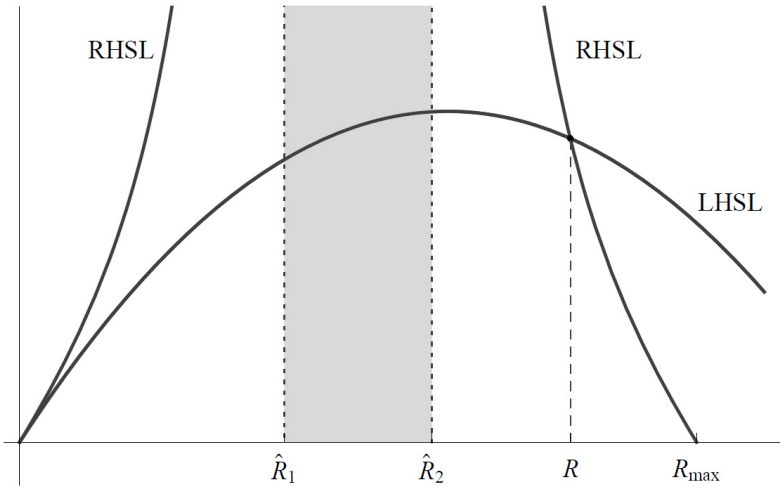
By comparing Proposition 3 to Proposition 2 it can be seen that the slope condition in the model without harvest cost translates to the similar condition in the model with relatively small constant unit harvest costs (see Fig. 3).[15]

**Fig. 3. A unique and asymptotically stable stationary state $R < R_{MSY}$ in model with small constant unit harvest cost**




[15] Fig. 3 is drawn for $\lambda = 0.014$, and Fig. 4 for $\lambda = 0.09$. For both figures, $\beta = 0.55$. All other model parameters are set as for Fig. 1.

**Fig. 4. A unique and asymptotically stable stationary state $R > R_{MSY}$ in model with relatively large constant unit harvest cost; the gray shaded area indicates where the resource stock price would be negative**




But in contrast to the model without harvest cost, the positivity of the resource stock price $p$ is no longer fulfilled for all biologically feasible resource stocks as Fig. 3 illustrates. While both to the left of $\hat{R}_1$ and to the right of $\hat{R}_2$ the resource stock price would be positive, the unique, and asymptotically stable stationary state market equilibrium is found at the right arm of $\mathrm{RHSL}$. This stationary state is characterized by a relatively high harvest cost parameter, i.e. $\lambda > (4\alpha)/(rR_{\max})$ which induces a low harvest level and a high stationary state resource stock.

The economic intuition of this result is that when the harvest cost parameter is large, decision makers have a higher incentive to keep the resource stock large because for larger resource stocks and consequently small harvest volumes the harvesting effort is smaller than the production elasticity of harvest input in resource processing. In contrast, when the harvest cost parameter is small, harvesting volumes are large and hence the harvesting effort is larger than the production elasticity of harvesting input in resource processing.

Since Krutilla and Reuveny (2004) find multiple solutions in a one-sector ILA model due to harvest cost which impact on the resource stock regeneration while Elíasson and Turnovsky (2004) do not in a two-sector ILA model with labor using harvest cost, it remains to be discussed whether harvest costs can lead to multiple solutions in a resource based OLG framework. In our model setting with log-linear utility and Cobb-Douglas technology, the answer is no - on the one hand due to labor using harvest costs and on the other due to log-linear utility and Cobb-Douglas production technology (as in OLG models with endogenous labor supply: see Lloyd-Braga et al. (2007)). We will show in the next section that this result carries also over to the case of inversely stock dependent harvest cost.

### 3.3. Model with inversely stock dependent harvest cost

As for constant unit harvest cost, economic feasibility may be violated over some ranges of biologically feasible resource stock values. Thus, we need to distinguish now two cases for the existence of a stationary state resource stock.

**Proposition 4 (Existence, uniqueness, and stability with inversely stock dependent harvest cost)**

For $h(R) = \lambda / R$, a unique and asymptotically stable nontrivial stationary state solution with $p > 0$ exists if $\lambda < \alpha / r, 1 - (1 - \gamma)r > 0$ and moreover $1 + r < \{(1-\gamma)[1-(1-\alpha)\lambda r] + \gamma\alpha - \lambda r\} r / (\alpha - \lambda r)$, or if $\lambda \geq \alpha / r$.

**Proof 4:** See Appendix A.3.

Again, the first case ($\lambda < \alpha / r$) of Prop. 4 is a generalization of the slope condition in Prop. 2 (model without harvest costs). As a consequence of stock dependent harvest costs, the first case (small harvest cost parameter) is valid for a larger range of $R$ values as compared to the case with constant unit harvest costs (Fig. 5). This is the case as inverse stock dependent harvest cost imply for a small resource stock that unit harvest costs are high while they decrease with a larger resource stock.

**Fig. 5. A unique and asymptotically stable stationary state $R < R_{MSY}$ in model with stock dependent harvest cost and a small harvest cost parameter**

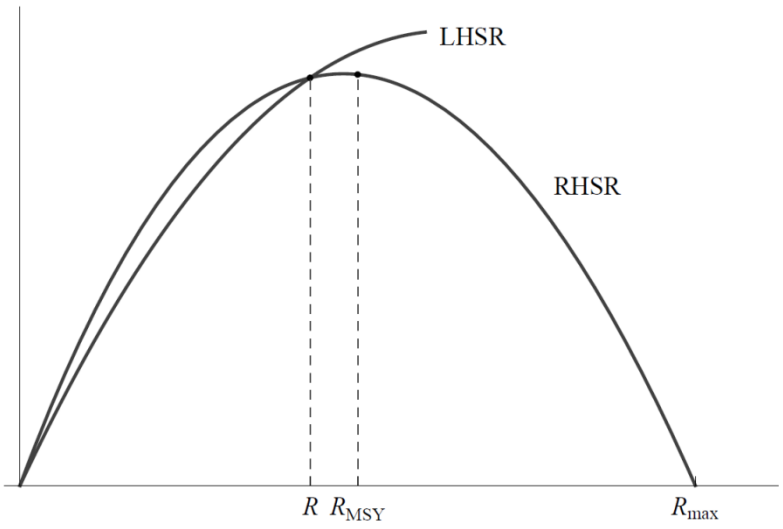
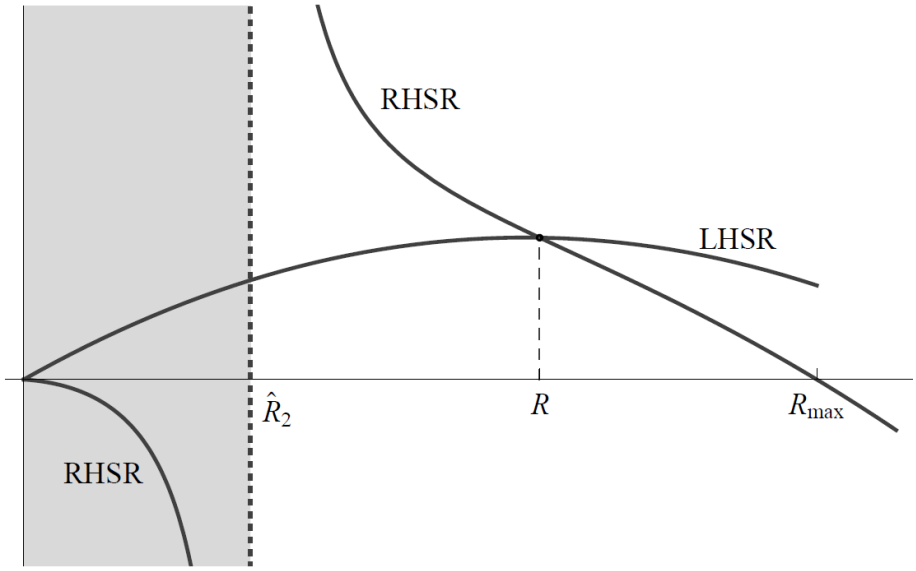


**Fig. 6. A unique and asymptotically stable stationary state $R > R_{MSY}$ in model with stock dependent harvest cost and a relatively large harvest cost parameter; the gray shaded area indicates where the resource stock price would be negative**




For the second case (large harvest cost parameter), illustrated in Fig. 6, again no slope restriction is necessary. Yet, relative to the case with constant unit harvest cost, the harvest cost parameter needs to be larger when harvest costs depend inversely on the resource stock. The reason is again that for a large resource stock, average harvest costs decline with a larger resource stock – an effect which cannot emerge when harvest costs only depend on harvest volume but not on the resource stock.

## 4. Intergenerational efficiency of stationary state market equilibrium

Knowing that a unique and asymptotically stable stationary state exists, we investigate when the stationary state market solution is intergenerationally efficient. This is particularly relevant given the fact that the nontrivial stationary state solutions may or may not be efficient in an OLG model with a renewable resource even without harvest costs (Koskela et al., 2002).

To derive the conditions for stationary intergenerational efficiency, we set up the problem of a social planner who maximizes utility of each individual living in the stationary state and require that the utility of the oldest generation alive in the initial period (denoted by subscript 0) achieves a predefined level:[16]

[16] Koskela et al. (2002) alternatively put the utility function of the initially old generation with a positive weight into the welfare function of the social planner.

$$\max\ u(C^1, C^2) = \ln C^1 + \beta \ln C^2$$

subject to

$$(i)\ \ln C_0^2 = \ln(C_0^2)^\circ\,,$$

$$(ii)\ C^1 + C_0^2 = X^\alpha [1 - h(R_0)X]^{(1-\alpha)}\,,$$

$$(iii)\ C^1 + C^2 = X^\alpha [1 - h(R)X]^{(1-\alpha)}\,,$$

$$(iv)\ X = g(R)\,,$$

$$(v)\ R + X = R_0 + g(R_0)\,,$$

$$(vi)\ (C_0^2, C^1, C^2) \geq 0,\ R \geq 0,\ X \geq 0.$$

where $R_0 > 0$ is the resource stock owned by the initially old generation.

To see whether individual utility and profit maximization in perfectly competitive markets lead to intergenerational efficiency, we compare household and firm first order conditions (2)–(9) as well as market clearing conditions in the stationary state market equilibrium to the intergenerational efficiency conditions (see equations (A.5) in the Appendix). We start again with the reference case without harvest cost before proceeding to linear and inversely stock dependent harvest cost.

### 4.1. Reference case without harvest cost

Proposition 5 states under which conditions the stationary market equilibria without harvest cost are intergenerationally efficient and considers Diamond's (1965) 'Golden Age', in which the utility of the initially old generation is disregarded as constraint for utility maximization of the young generation in the stationary state, as a special case.

**Proposition 5 (Intergenerational efficiency without harvest cost)**
For $h(R) = 0$ the stationary market equilibrium $R$ from (10) is intergenerationally efficient if $g'(R) > 0$, and it is Golden Age if $\mu_{-1}^C = 0$ and $g'(R) = 0$. Otherwise, the stationary state market equilibrium is intergenerationally inefficient.

**Proof 5:** See Appendix A.5.

The two possible cases are illustrated by Figs. 1-2. In Fig. 1, the stationary state market equilibrium is intergenerationally efficient – the stationary resource stock exhibits, because of the no-arbitrage condition, a positive own rate of return (underaccumulation of the resource stock occurs). This resource stock is below the Golden Age resource stock which coincides with the maximum sustainable yield level $R_{MSY}$.

The opposite case is illustrated by Fig. 2 in which $g'(R) < 0 \Leftrightarrow R > R_{MSY}$ and hence the stationary state market equilibrium is intergenerationally inefficient. Thus, a central planner could increase the welfare of the present and all future generations by a reduction in resource accumulation.

### 4.2. Constant unit harvest cost

In case of constant unit harvest cost, the constant harvest cost parameter $\lambda$ enters both the stationary market equilibrium and the intergenerational efficiency conditions. As a consequence, a specific value of the harvest cost parameter denoted by $\lambda^E$ determines the range of stationary market equilibria which are intergenerationally efficient. This is summarized in Prop. 6.

**Proposition 6 (Intergenerational efficiency with constant unit harvest cost)**

If for $h(R) = \lambda$ unit harvest cost satisfies $0 < \lambda < \lambda^E$, where $\lambda^E \equiv [8\alpha - 4(1-\gamma)r]/\{r[2-(1-\gamma)r]R_{\max}\}$, then the stationary market equilibrium is intergenerationally efficient. The Golden Age applies when $\lambda = \lambda^E$. When $\lambda > \lambda^E$, the stationary market equilibrium is intergenerationally inefficient.

**Proof 6:** See Appendix A.6.

The two cases are illustrated in Figs. 3-4. In Fig. 3, $\lambda < \lambda^E$ which is equivalent to $R < R_{\max}/2 = R_{MSY}$, and hence the stationary market equilibrium is intergenerationally efficient. Note the similarity here to the model without harvest costs: intergenerational efficiency is obtained when the own rate of return on the resource stock $g'(R)$ is positive in the stationary state market equilibrium. The opposite case with a negative rate of return, i.e. where $\lambda > 4\alpha/(rR_{\max}) > \lambda^E$ holds, is illustrated in Fig. 4 and hence the stationary market equilibrium is intergenerationally inefficient.

To understand why a stationary market solution with large harvest cost parameter $\lambda$ is intergenerationally inefficient, it is useful to evaluate the consequences which a higher harvest cost parameter has for the equilibrium resource stock. The higher harvesting costs, the more costly it is to harvest, the lower is the resource harvest and its use in resource processing. As a consequence, most of labor will be devoted to resource processing instead of harvesting. But due to decreasing productivity of labor in resource processing, output and hence welfare could be increased when more labor would be devoted to harvesting.

### 4.3. Inversely stock dependent harvest cost

In case of inversely stock dependent harvest cost, unit harvest cost are not constant but decrease with increasing resource stock value. In contrast to the case of constant unit harvest cost, a critical value of the harvest cost parameter $\lambda^E$ cannot

be stated in general except for the Golden Age case. Instead, the value of the harvest cost parameter ensures that the shadow prices corresponding to constraints (A.5c) and (A.5d) in Appendix A.5 are positive. This is summarized in Prop. 7.

**Proposition 7 (Intergenerational efficiency with stock dependent harvest cost)**

Let $h(R) = \lambda / R$. For all $\lambda > 0$ such that (7)-(9) allow for $\phi_0^R / \phi^R > 0$ and $\phi_0^Y / \phi^Y > 0$, the stationary state market equilibrium is intergenerationally efficient. The Golden Age applies when $\lambda = \lambda^E$, where $\lambda^E \equiv (1-\gamma)[2\alpha - (1-\gamma)r] / \{[(1-\gamma)r - \alpha][1 + \alpha - (1-\gamma)r]\}$, and $R^E \equiv (\alpha R_{\max}) / [(1-\gamma)r]$. When $\lambda > \alpha / r$, the stationary market equilibrium is intergenerationally inefficient.

**Proof 7:** See Appendix A.7.

Although complicated, one can see from condition (A.7) in the Appendix A.7 that for intergenerational efficiency ($\phi^R / \phi^Y > 0$) a strictly positive own rate of return on natural capital is not necessary. The two cases of Prop. 7 are again illustrated in Figs. 5-6. In Fig. 6, the harvest cost parameter is large ($\lambda > \alpha / r > \lambda^E$)and therefore the stationary market equilibrium is intergenerationally inefficient. For a harvest cost parameter $\lambda$ such that $\phi_0^R / \phi^R > 0$ and $\phi_0^Y / \phi^Y > 0$, the stationary market equilibrium is intergenerationally efficient, as illustrated in Fig. 5.

Comparing these results to the model without harvest cost where a positive own rate of return on the resource stock is required for intergenerational efficiency, it can be concluded that a weaker but far more complicated condition is needed in the model with inversely stock dependent harvest costs. The reason for that is that inversely stock dependent harvest costs have additional effects on both the size of the stationary state resource stock and the harvest level.

## 5. Discussion and conclusions

This paper compared different specifications of harvest cost in an OLG model with a renewable natural resource similar to Koskela et al. (2002). The first key insight is that zero harvest costs must not be considered as a special case of constant unit harvest costs or inversely stock dependent harvest cost in this type of model, essentially for two reasons.

First, because of resource harvest competing with resource processing for labor, some biologically feasible resource stocks would eventually lead to a negative resource stock price and hence would be economically infeasible. In particular, for a positive resource stock price the production elasticity of resource input (or, equivalently, the resource input production share) has to exceed total harvest effort for a given resource stock. For constant unit harvest costs this condition is fulfilled when the resource stock is small or large but not for intermediate values because with an intermediate sized resource stock harvest volumes and hence total harvest costs are large. In contrast, when harvest costs additionally depend inversely on the

stock, unit harvest costs decline with a larger resource stock and hence the feasibility condition requiring a sufficiently larger production elasticity of resource input is easier fulfilled for a larger resource stock.

Second, the magnitude of harvest cost, and in particular of the size of the harvest cost parameter, is also instrumental for the existence of a stationary state solution. While without harvest costs a slope condition needs to hold at the origin to ensure the existence of a stationary state, no such condition is required with a sufficiently large harvest cost parameter. As for feasibility, the argument is again that higher total harvest costs imply a comparatively large stationary state resource stock which lies to the right of a strictly positive pole and hence no restrictions at the origin are required.

In addition to investigating the difference to the model without harvest cost, our objective was to study the potentially different impacts of alternative specifications of harvest costs. Here we find that inversely stock dependent harvest cost favor the existence of a nontrivial stationary state because harvest costs increase with a smaller resource stock. Thus, while unit harvest costs are small for a large resource stock, they become large for a small resource stock which provides a disincentive for overexploitation of the resource stock. This effect is not present when harvest costs depend only on the harvest volume but not the stock.

Moreover, when comparing the two types of harvest costs, there is another important difference in regard to intergenerational efficiency. While the efficiency condition requiring positivity of the own rate of return on the resource stock carries over to the model with constant unit harvest costs, this is not required in the model with inversely stock dependent harvest cost. In particular, only a weaker condition needs to hold and hence a stationary state market equilibrium in the model with stock dependent harvest cost may also be intergenerationally efficient even when the own rate of return is negative, i.e. when the resource stock lies to the right of the maximum sustainable yield level.

Yet, despite inversely stock dependent harvest cost, the higher the harvest cost parameter is the more likely a stationary state market equilibrium may eventually be intergenerationally inefficient. This is due to the fact that the higher total harvest costs the lower is resource harvest and the use of resource harvest in resource processing. As a consequence, most of labor will be devoted to resource processing instead of harvesting. But due to decreasing productivity of labor in resource processing, output and hence welfare could be increased when more labor would be devoted to harvesting.

The analytical limitations of this paper are rather obvious: we are working with widely-used but rather specific functional specifications of the intertemporal utility function, the production function, the regeneration and the harvest cost function. We conjecture that our main substantial results will go through even under more general functional specifications but it is open to prove this conjecture. Remaining within our rather specific functional specifications the following directions for extending the scope of this paper are easily identified. First, instead of linear harvest cost, a quadratic specification as in Maroto et al. (2012) could be used. Second, the inverse impact of the resource stock could be reversed such that harvest costs increase with the resource stock, a specification suitable e.g. for species-rich ecosystems like tropical forests. Finally, also fixed costs could be considered, which may give rise to non-convexities (as in Kennedy and Barbier, 2015).

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# A. Appendix

## A.1 Proof to Proposition 1

To show how the denominator of (10) is decisive for the positivity of the resource stock price $p$, we substitute for the firm's first order conditions in (8) and evaluate the resulting expression at the stationary state:

$$p = \frac{\{[\alpha - h(R)g(R)][1 + g'(R)] - (1-\alpha)h'(R)g(R)^2\}g(R)^{\alpha}[1 - h(R)g(R)]^{(1-\alpha)}}{g(R)[1 - h(R)g(R)]} \tag{A.1}$$

Inspecting the numerator of (A.1) reveals that all expressions are clearly positive except for $[\alpha - h(R)g(R)]$. Thus, a necessary and sufficient condition for a positive stationary state resource stock price, and hence an economically feasible resource stock, is that $[\alpha - h(R)g(R)] > 0$.

Focusing first on the case of linear harvest cost, i.e. $h(R) = \lambda$, the feasibility requirement reduces to $[\alpha - \lambda g(R)] > 0$, and implies that the right hand side of (13) exhibits two poles between which the resource stock price would become negative. With inversely stock dependent harvest cost, the economic feasibility requirement reduces to $[\alpha R - \lambda g(R)] > 0$, and thus one pole results for (13), and left of this pole the resource stock price would become negative. Finally, without harvest cost the feasibility requirement is equal to $\alpha > 0$, and thus no pole emerges. Hence, without harvest cost the resource stock price is positive for the whole range of biologically feasible resource stock values ($R \in (0, R_{\max})$).

For $h(R) = \lambda$, denote the left hand side of (13) by $\mathrm{LHSL}(R)$ and the right hand side by $\mathrm{RHSL}(R)$ and the denominator of the latter by $\mathrm{BL}(R) \equiv \alpha - \lambda g(R)$. For logistic regeneration, the poles of $\mathrm{BL}(R) = 0$ can be calculated as $\hat{R}_{1,2} = R_{\max}/2 \pm \sqrt{[\lambda r R_{\max}(\lambda r R_{\max} - 4\alpha)]/(2\lambda r)}$. Both solutions are real if $\lambda r R_{\max} - 4\alpha \geq 0 \Leftrightarrow \lambda \geq (4\alpha)/(r R_{\max})$. If on the other hand $\lambda r R_{\max} - 4\alpha < 0$, no pole emerges for $\mathrm{RHSL}(R)$.

For $h(R) = \lambda / R$, denote again the left and right hand side of (13) by $\mathrm{LHSR}(R) \equiv \Psi(R)$ and by $\mathrm{RHSR}(R) \equiv g(R)\{[1 - \gamma(1-\alpha)]R - [1 + (1-\gamma)(1-\alpha)]g(R)\lambda\}/\mathrm{BR}(R)$ where $\mathrm{BR}(R) \equiv [\alpha R - \lambda g(R)]$. By setting $\mathrm{BR}(R) = 0$, we find two poles of $\mathrm{RHSR}(R)$: $\hat{R}_1 = 0$ and $\hat{R}_2 = [(\lambda r - \alpha)R_{\max}]/(\lambda r)$. For $\lambda r = \alpha$, $\hat{R}_1 = \hat{R}_2 = 0$, while for $\lambda > \alpha / r$ only the second pole $\hat{R}_2$ exists. Q.E.D.

## A.2 Proof to Proposition 2

For the proof of the *existence* of the stationary state solution, note that at the origin, $\mathrm{LHS0}(0) = \mathrm{RHS0}(0) = 0$ but by assumption $\lim_{R->0^+} \mathrm{LHS0}'(R) < \lim_{R->0^+} \mathrm{RHS0}'(R)$. On the other hand, $\mathrm{LHS0}(R_{\max}) = [1 - (1-\gamma)r]R_{\max}$ and

$\mathrm{RHS0}(R_{\max}) = 0$ and hence, by assumption of $[1-(1-\gamma)r] > 0$, $\mathrm{LHS0}(R_{\max}) > \mathrm{RHS0}(R_{\max})$. Since both $\mathrm{LHS0}(R)$ and $\mathrm{RHS0}(R)$ are continuous functions on $[0, R_{\max}]$, an intermediate value theorem ensures the existence of a $0 < R < R_{\max}$ such that $\mathrm{LHS0}(R) = \mathrm{RHS0}(R)$.

For the *uniqueness* of the stationary state solution, we need to distinguish the range of $R$ on which $\mathrm{LHS0}(R)$ and/or $\mathrm{RHS0}(R)$ are monotonically increasing or decreasing. Assume first that the model parameters are such that the stationary state solution lies in $(0, R_{\max}/2]$. Knowing that both $\mathrm{LHS0}(R)$ and $\mathrm{RHS0}(R)$ are monotonically increasing in $(0, R_{\max}/2]$ and moreover that $\lim_{R->R_{\max}/2}\mathrm{LHS0}'(R) = 1 - r(1-\gamma) > \lim_{R->R_{\max}/2}\mathrm{RHS0}'(R) = 0$, functions $\mathrm{LHS0}(R)$ and $\mathrm{RHS0}(R)$ intersect exactly once on the interval $(0, R_{\max}/2]$.

If, on the other hand, the stationary state lies in $(R_{\max}/2, R_{\max})$, $\mathrm{RHS0}(R)$ is monotonically decreasing. If $\mathrm{LHS0}(R)$ is increasing, the intersection point with $\mathrm{RHS0}(R)$ is unique. In the opposite case of decreasing $\mathrm{LHS0}(R)$, the slope of $\mathrm{RHS0}(R)$ is larger than that of $\mathrm{LHS0}(R)$ since $\mathrm{LHS0}(R_{\max}) = 1 - r(1-\gamma) > \mathrm{RHS0}(R_{\max}) = 0$.

For *local asymptotic stability* of the stationary state solution, we have to show that $0 < dR_{t+1}/dR_t < 1$ holds at the stationary state $R$ which is equivalent to $dR_{t+1}/dR_t = 1 + g'(R) - dX_t/dR_t > 0$ and $g(R) < dX_t/dR_t$. In order to show that $1 + g'(R) - dX_t/dR_t > 0$, we investigate the intertemporal equilibrium dynamics:

$$\Psi(R_t) = \frac{X_t R_t[1-\gamma(1-\alpha)] - (X_t)^2[h(R_t)R_t - (1-\gamma)(1-\alpha)h'(R_t)(R_t)^2]}{(R_t)^2[\alpha - h(R_t)X_t]}. \quad \text{(A.2)}$$

Considering that $h(R) = 0$ in (A.2) gives $X_t = \alpha/(\alpha+\beta)\{R_t + g(R_t) + \beta[1+g'(R_t)]R_t\}$ which yields for the first derivative $dX_t/dR_t(R) = \alpha/(\alpha+\beta)\{[1+g'(R)](1+\beta) - \beta g''(R)R\}$ and hence $dR_{t+1}/dR_t(R) = [1+g'(R)]\beta(1-\alpha)/(\alpha+\beta) - (\alpha\beta)/(\alpha+\beta)g''(R)R > 0$ since $g''(R) < 0$.

In order to show that $-g'(R) < dX_t/dR_t(R)$, we have to distinguish the range of $R$ on which $g'(R) \geq 0$ from that on which $g'(R) < 0$. Assume first that the model parameters are such that the stationary state solution lies in $(0, R_{\max}/2)$. Then, clearly $g'(R) \geq 0$ and $\mathrm{RHS0}'(R) \geq 0$. This is also true for $\mathrm{LHS0}'(R)$, because $\mathrm{LHS0}'(R) = 1 + r + [2(\gamma-2)rR]/R_{\max}$ is positive for $R = R_{\max}$ and therefore a fortiori also positive for smaller $R$. Since moreover $\mathrm{RHS0}'(R_{\max}/2) < \mathrm{LHS0}'(R_{\max}/2)$ and by assumption $\lim_{R->0^+}\mathrm{LHS0}'(R) < \lim_{R->0^+}\mathrm{RHS0}'(R)$, it follows from continuity of $\mathrm{LHS0}'(R)$ and $\mathrm{RHS0}'(R)$ that for $R \in (0, R_{\max}/2)$ $\mathrm{LHS0}'(R) > \mathrm{RHS0}'(R)$ $\Leftrightarrow \alpha/(\alpha+\beta)\{(1+\beta)[1+g'(R)] + \beta g''(R)R\} > g'(R)$.

Second, assume that the stationary state $R \in (R_{\max}/2, R_{\max})$. Clearly, $g'(R) < 0$ and $\mathrm{RHS0}'(R) < 0$. If moreover $\mathrm{LHS0}'(R) \geq 0$, the claim that $\mathrm{LHS0}'(R) > \mathrm{RHS0}'(R)$ is proven. If, on the other hand $\mathrm{LHS0}'(R) < 0$, the (negative) slope of $\mathrm{RHS0}(R)$ is larger than the (negative) slope of $\mathrm{LHS0}(R)$, because for $R = R_{\max}$ $\mathrm{LHS0}(R_{\max}) = 1 - r(1-\gamma) > \mathrm{RHS0}(R_{\max}) = 0$ and thus $\mathrm{RHS0}'(R) < \mathrm{LHS0}'(R)$ holds a fortiori for $R \in (R_{\max}/2, R_{\max})$. Q. E. D.

A.3 Proof to Proposition 3

To proof the *existence* and *uniqueness* of the stationary states with constant unit harvest costs, according to Prop. 3 we have to distinguish for three cases:

i. Focusing first on the case $\lambda r R_{\max} - 4\alpha < 0$, we have $\mathrm{BL}(R) > 0$ for $R \in (0, R_{\max}]$. Analogously to the *existence* proof to Proposition 2 it is easy to verify that $\mathrm{LHSL}(0) = \mathrm{RHSL}(0)$ (see Fig. 3). On the other hand, when $[1-(1-\gamma)r] > 0$, $\mathrm{LHSL}(R_{\max}) = [1-(1-\gamma)r]R_{\max} > \mathrm{RHSL}(R_{\max}) = 0$.
Since both functions are continuous on $R \in (0, R_{\max}]$ and by assumption $\lim_{R->0^+} \mathrm{LHSL}'(R) < \lim_{R->0^+} \mathrm{RHSL}'(R)$, at least one stationary state solution exists.
For the *uniqueness* of the stationary state, we need again to distinguish the range of $R$ on which $\mathrm{LHSL}(R)$ and $\mathrm{RHSL}(R)$ are monotonically increasing or decreasing. Assume first that the model's parameters ($\lambda$ included) are such that the stationary state solution lies in $(0, R_{\max}/2]$. We know from the proof of Proposition 2 that for $R \in (0, R_{\max}/2]$ $\mathrm{LHSL}'(R) > 0$ and also $\mathrm{RHSL}'(R) \geq 0$ because $\lim_{R->0^+} \mathrm{RHSL}'(R) = [1-(1-\alpha)\gamma]r/\alpha > 0$ and $\lim_{R->R_{\max}/2} \mathrm{RHSL}'(R) = 0$. Since $\lim_{R->R_{\max}/2} \mathrm{LHSL}'(R) > 0$, functions $\mathrm{LHSL}(R)$ and $\mathrm{RHSL}(R)$ intersect once on the interval $(0, R_{\max}/2]$.
On the other hand, for a stationary state $R \in (R_{\max}/2, R_{\max})$, $\mathrm{RHSL}'(R)$ is monotonically decreasing. If $\mathrm{LHSL}'(R) > 0$, the intersection point is unique. In the opposite case of $\mathrm{LHSL}'(R) < 0$, the slope of $\mathrm{RHSL}(R)$ is larger (in absolute terms) than that of $\mathrm{LHSL}(R)$ since $\mathrm{LHSL}(R_{\max}) = [1-r(1-\gamma)]R_{\max}$ $> \mathrm{RHSL}(R_{\max}) = 0$. Thus, the intersection is unique, too.

ii. For the case of $\lambda r R_{\max} - 4\alpha = 0$, there is one pole $\hat{R} = R_{\max}/2$. Since $g(R)$ is maximal for $R = R_{\max}/2$ and $\mathrm{BL}(R_{\max}/2) = 0$, it follows that $\mathrm{BL}(R) > 0$ for all other admissible $R$. However, as $\lim_{R->0^+} \mathrm{LHSL}'(R) < \lim_{R->0^+} \mathrm{RHSL}'(R)$ and moreover $\lim_{R->R_{\max}/2} \mathrm{RHSL}(R) = +\infty$, $\mathrm{RHSL}(R) \neq \mathrm{LHSL}(R)$ for all $R$

in $(0, R_{\max}/2]$. To the right of the pole, i.e. $R \in (R_{\max}/2, R_{\max})$, $\mathrm{RHSL}(R)$ decreases monotonically with larger $R$ with $\lim_{R->R_{\max}/2} \mathrm{RHSL}(R) = +\infty$ and $\lim_{R->R_{\max}} \mathrm{RHSL}(R) = 0$. On the other hand, $\mathrm{LHSL}'(R_{\max}/2) = 0$ and $\mathrm{LHSL}(R_{\max}) > 0$. Since both $\mathrm{LHSL}(R)$ and $\mathrm{RHSL}(R)$ are continuous functions of $R \in (R_{\max}/2, R_{\max})$, an intermediate value theorem ensures a solution $\mathrm{LHSL}(R) = \mathrm{RHSL}(R)$. The solution is again unique because the slope of $\mathrm{RHSL}(R)$ is negative and the slope of $\mathrm{LHSL}(R)$ is positive or negative but in the latter case certainly smaller (in absolute terms) than that of $\mathrm{RHSL}(R)$.

iii. If $\lambda r R_{\max} - 4\alpha > 0$, two poles $\hat{R}_1$ and $\hat{R}_2$ occur (see Fig. 3). It is not difficult to see that $\mathrm{BL}(R) > 0$ for $R \in [0, \hat{R}_1) \cup (\hat{R}_2, R_{\max})$ and $\mathrm{BL}(R) < 0$ for $R \in [\hat{R}_1, \hat{R}_2]$. By an analogous argument as in case (ii), it can be shown that $\mathrm{RHSL}(R) \neq \mathrm{LHSL}(R)$ for $R \in [0, \hat{R}_1)$ while there is a unique solution in $(\hat{R}_2, R_{\max})$.

In order to prove *local asymptotic stability* of the stationary state over the interval $(0, R_{\max}/2]$ and $(R_{\max}/2, R_{\max})$ we need to show that $0 < dR_{t+1}/dR_t < 1 \Leftrightarrow 1 + g'(R) - dX_t/dR_t(R) > 0 \wedge g'(R) < dX_t/dR_t(R)$. Deriving again $dX_t/dR_t(R)$ in (2) for the case of constant unit harvest cost yields:

$$1 + g'(R) - dX_t/dR_t(R) = \frac{[1+g'(R)]\alpha\beta(1-\alpha) - (\alpha - \lambda g(R))^2 \beta g''(R) R}{[\alpha(\alpha+\beta) - 2\alpha(1+\beta)\lambda g(R) + (1+\beta)\lambda^2 g(R)^2]}. \quad \text{(A.3)}$$

The numerator of (A.3) is certainly positive because of $g''(R) < 0$ but the sign of the denominator is not obvious. But in fact, the denominator is larger than zero because it is minimal at $g(R) = \alpha/\lambda$, since for this value of $g(R)$ the denominator of (A.3) equals $\alpha(1+\beta)(1-\alpha) > 0$. Obviously, for all other values of $g(R)$ the denominator is larger and therefore $1 + g'(R) - dX_t/dR_t$ is larger than zero for all $R \in (0, R_{\max})$.

To show that $g'(R) < dX_t/dR_t$, we need to distinguish again the range of $R$ on which $g'(R) \geq 0$ or $g'(R) < 0$. Consider first the case in which the stationary state solution lies in $(0, R_{\max}/2]$ and hence $g'(R) \geq 0$ and $\mathrm{RHSL}'(R) > 0$ since $\mathrm{RHSL}'(R)$ $\lim_{R->0^+} \mathrm{RHSL}'(R) = [1-(1-\alpha)\gamma]r/\alpha > 0$ and $\lim_{R->R_{\max}/2} \mathrm{RHSL}'(R) = 0$ and $\mathrm{RHSL}'(R)$ is continuous. In analogy to the proof of Proposition 2 we know that $\mathrm{LHSL}'(R) > 0$ for all $R$ in $(0, R_{\max})$. Thus, since by assumption $\lim_{R->0^+} \mathrm{LHSL}'(R) <$ $\lim_{R->0^+} \mathrm{RHSL}'(R)$ and $\mathrm{LHSL}'(R_{\max}/2) > \mathrm{RHSL}'(R_{\max}/2)$, it follows from continuity

of $\mathrm{LHSL}'(R)$ and $\mathrm{RHSL}'(R)$ that

$$\mathrm{LHSL}'(R) = \{[1+g'(R)](1+\beta)+\beta g''(R)R\}/(1+\beta) >$$

$$\mathrm{RHSL}'(R) = g'(R)\{\alpha(\alpha+\beta)-2\alpha(1+\beta)\lambda g(R)+(1+\beta)\lambda^2 g(R)^2\}\big/(1+\beta)[\alpha-\lambda g(R)]^2$$

which equals $g'(R) < dX_t/dR_t(R)$ for $R \in (0, R_{\max}/2]$.

Assume now that the stationary state solution lies in $(R_{\max}/2, R_{\max})$ and therefore $g'(R) < 0$ and $\mathrm{RHSL}'(R) < 0$. If again $\mathrm{LHSL}'(R) \geq 0$, the claim is proven. If not, the (negative) slope of $\mathrm{RHSL}(R)$ is larger than the (negative) slope of $\mathrm{LHSL}(R)$, i.e. $\mathrm{RHSL}'(R) < \mathrm{LHSL}'(R)$ since $\mathrm{LHSL}(R_{\max}) = [1-r(1-\gamma)]R_{\max} > \mathrm{RHSL}(R_{\max}) = 0$. Q.E.D.

A.4 Proof to Proposition 4

We start again by proving the existence of a stationary state solution were we have to distinguish for the cases identified in Proposition 1. Commencing with the second case, $\lambda < \alpha/r$, it is easy to show that $\mathrm{BR}(R) > 0$ for all $R \in (0, R_{\max})$ (see Fig. 5). As in the proof to Prop. 3, we can show for this case that $\mathrm{LHSR}(R) = \mathrm{RHSR}(R)$ for $0 < R < R_{\max}$ if $-1-(1-\gamma)r > 0$ and moreover $\lim_{R->0^+} \mathrm{LHSR}'(R) < \lim_{R->0^+} \mathrm{RHSR}'(R)$ and hence a stationary state solution exists.

On the other hand, when $\lambda \geq \alpha/r$ either $\hat{R}_1 = \hat{R}_2 = 0$ or only the pole $\hat{R}_2 > 0$ exists. For $R \in (0, \hat{R}_2)$, $\mathrm{BR}(R) < 0$ since $\mathrm{BR}'(R) > 0$. Thus, $\mathrm{LHSR}(R)$ needs to intersect $\mathrm{RHSR}(R)$ to the right of the pole, i.e. $R \in (\hat{R}_2, R_{\max})$ where $\mathrm{BR}(R) > 0$ (see Fig. 6). Hence, $\lim_{R->\hat{R}_2} \mathrm{RHSR}(R) = +\infty$ while $\mathrm{LHSR}(\hat{R}_2) < \infty$. On the other hand, $\mathrm{RHSR}(R_{\max}) = 0$ while $\mathrm{LHSR}(R_{\max}) > 0$. As a consequence of the continuity of both $\mathrm{LHSR}(R)$ and $\mathrm{RHSR}(R)$ for $R \in (\hat{R}_2, R_{\max})$, $\mathrm{LHSR}(R) = \mathrm{RHSR}(R)$ for $\hat{R}_2 < R < R_{\max}$.

The proof of the *uniqueness* is analogous to the proof to Prop. 3.

In order to prove local asymptotic stability of the stationary state $R \in (0, R_{\max})$ we have to show again that $0 < dR_{t+1}/dR_t < 1 \Leftrightarrow 1+g'(R)-dX_t/dR_t > 0 \wedge g'(R) < dX_{t+1}/dX_t$ both for $R \in (0, R_{\max}/2]$ and for $R \in (R_{\max}/2, R_{\max})$:

$$\begin{aligned} &1+g'(R)-dX_t/dR_t = \\ &\frac{\beta(1-2\alpha)R+\lambda R[1+\beta(1+g'(R))]-\beta\lambda g(R)(3-2\alpha)[1+g'(R)]}{\{(\alpha+\beta)R+\lambda R(1+g'(R))]+\lambda g(R)\{1-2[1+\beta(2-\alpha)]\}\}} \\ &-\frac{\beta g''(R)R(\alpha R-\lambda g(R))+\beta g(R)-\alpha R}{\{(\alpha+\beta)R+\lambda R(1+g'(R))]+\lambda g(R)\{1-2[1+\beta(2-\alpha)]\}\}}. \end{aligned} \tag{A.4}$$

The denominator of (A.4) is larger than zero for all $R \in (0, R_{\max})$ because the denominator is minimal at $R = 0$ and maximal at $R = R_{\max}$ and is strictly monotonically increasing on the interval $(0, R_{\max})$ since the second derivative of the denominator with respect to $R$ equals $\{2[1 + 2(1-\alpha)\beta]\lambda r\} / R_{\max} > 0$. The same holds true with respect to the first bracket of the numerator since the second derivative of the expression in the bracket equals $2(1-2\alpha)\beta\lambda r / R_{\max} > 0$. One can show that $[(\beta - \alpha)g(R) - \beta g''(R)R(\alpha R - \lambda g(R))]$ is minimal at $R = 0$ and maximal at $R = R_{\max}$ and that this term is increasing with $R$. Then, both the denominator and the numerator of (A.4) are positive for all $R \in (0, R_{\max})$.

To show that $g'(R) < dX_t / dR_t$, we need to distinguish again the range of $R$ on which $g'(R) \geq 0$ or $g'(R) < 0$. Consider first the case in which the stationary state solution lies in $(0, R_{\max}/2]$ and hence $g'(R) \geq 0$. Moreover, $\mathrm{RHSR}'(R) > 0$ since $\lim_{R->0^+} \mathrm{RHSR}'(R) = \{[\alpha + \beta - \lambda r(1 + 2\beta) + \alpha\beta\lambda r] r\} / (\alpha - \lambda r) > 0$ and $\lim_{R->R_{\max}/2} \mathrm{RHSR}'(R) = -(1-\alpha)^2 \beta\lambda r^2 / (2\alpha - \lambda r)^2 < 0$ and $\mathrm{RHSR}'(R)$ is continuous. Clearly, $\mathrm{LHSR}'(R) > 0$ for all $R$ in $(0, R_{\max})$. Thus, since by assumption $\lim_{R->0^+} \mathrm{LHSR}'(R) < \lim_{R->0^+} \mathrm{RHSR}'(R)$ and $\mathrm{LHSR}'(R_{\max}/2) > \mathrm{RHSR}'(R_{\max}/2)$, it follows from continuity of $\mathrm{LHSR}'(R)$ and $\mathrm{RHSR}'(R)$ that

$$\mathrm{LHSR}'(R) = \frac{[1 + g'(R)](1 + \beta) + \beta g''(R)R}{1 + \beta} >$$

$$\mathrm{RHSR}'(R) = \frac{(\alpha R - \lambda g(R))\{(\alpha + \beta)Rg'(R) + (\alpha + \beta)g(R) - 2\lambda g(R)[1 + \beta(2 - \alpha)]g'(R)\}}{[\alpha R - \lambda g(R)]^2}$$

$$- \frac{[\alpha - \lambda g'(R)]\{(\alpha + \beta)Rg(R) - \lambda g(R)^2[1 + \beta(2 - \alpha)]\}}{[\alpha R - \lambda g(R)]^2},$$

which equals $g'(R) < dX_t / dR_t$ for $R \in (0, R_{\max}/2]$.

If, on the other hand, $R \in (R_{\max}/2, R_{\max})$, $g'(R) < 0$ and $\mathrm{RHSR}'(R) < 0$. If $\mathrm{LHSR}'(R) \geq 0$, the claim is proven. If not, the (negative) slope of $\mathrm{RHSR}(R)$ is larger than the (negative) slope of $\mathrm{LHSR}(R)$, i.e. $\mathrm{RHSR}'(R) < \mathrm{LHSR}'(R)$ since $\mathrm{LHSR}(R_{\max}) > \mathrm{RHSR}(R_{\max}) = 0$. Q.E.D.

A.5 Proof to Proposition 5

Setting up the Lagrangian to the optimization problem in section 4

$$\begin{aligned}\Lambda = \ln C^1 + \beta \ln C^2 + \mu_{-1}^C[\ln C_0^2 - \ln(C_0^2)^\circ] \\ + \phi_0^Y [X^\alpha (1-h(R_0,X)X)^{(1-\alpha)} - C^1 - C_0^2] \\ + \phi^Y [X^\alpha (1-h(R,X)X)^{(1-\alpha)} - C^1 - C^2] \\ + \phi^R [g(R) - X] + \phi_0^R [R_0 + g(R_0) - R - X]\end{aligned}$$

yields the following first order conditions:

$$\frac{C^2}{\beta C^1} = 1 + \frac{\phi_0^Y}{\phi^Y}, \tag{A.5a}$$

$$\frac{\mu_{-1}^C}{C_0^2} = \phi_0^Y, \tag{A.5b}$$

$$\begin{aligned}&\phi_0^Y \{\frac{\alpha X^\alpha (1-h(R_0,X)X)^{(1-\alpha)}}{X} - \frac{(1-\alpha)X^\alpha (1-h(R_0,X)X)^{(1-\alpha)} h(R_0,X)}{(1-h(R_0,X)X)}\} \\ &+ \phi^Y \{\frac{\alpha X^\alpha (1-h(R,X)X)^{(1-\alpha)}}{X} - \frac{(1-\alpha)X^\alpha (1-h(R,X)X)^{(1-\alpha)} h(R,X)}{(1-h(R,X)X)}\} = \phi^R + \phi_0^R,\end{aligned} \tag{A.5c}$$

$$\phi^R g'(R) = \phi_0^R + \phi^Y (1-\alpha) X^\alpha [1-h(R,X)X]^{-\alpha} h'(R,X)X, \tag{A.5d}$$

$$\ln C_0^2 = \ln(C_0^2)^\circ, \tag{A.5e}$$

$$X^\alpha (1-h(R_0,X)X)^{(1-\alpha)} = C^1 + C_0^2, \tag{A.5f}$$

$$X^\alpha (1-h(R_0,X)X)^{(1-\alpha)} = C^1 + C^2, \tag{A.5g}$$

$$R_0 + g(R_0) = R + X, \tag{A.5h}$$

$$g(R) = X. \tag{A.5i}$$

For the reference case without harvest cost, intergenerational efficiency conditions (A.5c)-( A.5d) simplify to: $\alpha X^{\alpha-1} = (\phi^R + \phi_0^R)/(\phi^Y + \phi_0^Y)$, $\phi^R g'(R) = \phi_0^R$.

When moreover the utility of the initially old generation is disregarded as constraint for utility maximization of the young generation in the stationary state (= 'Golden Age'), $\mu_{-1}^C = 0$ and hence $\phi_0^Y = \phi_0^Y = 0$. Then, the remaining efficiency conditions collapse to:

$$C^2/(\beta C^1) = 1, \tag{A.5a'}$$

$$\alpha X^{(\alpha-1)} = \phi^R/\phi^Y, \tag{A.5c'}$$

$$g'(R) = 0, \tag{A.5d'}$$

$$X^\alpha = C^1 + C^2, \tag{A.5g'}$$

$$g(R) = X. \qquad \text{(A.5i')}$$

Assume first that the stationary market equilibrium is such that $g'(R) > 0$. Set provisionally $q = (\phi_0^R + \phi^R)/(\phi_0^Y + \phi^Y)$ and $g'(R) = \phi_0^Y / \phi^Y = \phi_0^R / \phi^R$. Then, the market equilibrium conditions evaluated at the stationary state, i.e.

$$C^2/(\beta C^1) = 1 + g'(R), \qquad p = q[1 + g'(R)], \qquad \text{(7'),(8')}$$

$$\alpha X^{(\alpha-1)} = q, \qquad w = (1-\alpha)X^{\alpha}, \qquad \text{(9')}$$

$$X^{\alpha} = C^1 + C^2,, \qquad X^{\alpha} = C^1 + C_o^2,, \qquad \text{(10')}$$

$$X = g(R), \qquad X + R = g(R_0) + R_0 \qquad \text{(4')}$$

imply (A.5a')-(A.5i').

Second, assume that $\mu_{-1}^C = 0$ and $g'(R) = 0$ hold in the stationary state market equilibrium. $g'(R) = 0$ yields the modified stationary state market equilibrium conditions

$$C^2/(\beta C^1) = 1, \qquad p = q. \qquad \text{(7''),(8'')}$$

But $\mu_{-1}^C = 0$ implies $\phi_0^Y = \phi_0^R = 0$. Hence we set $q = \phi^R / \phi^Y$, and the stationary state market equilibrium conditions, (4'), (7''), (8''), (9'), (10'), imply the Golden Age conditions (A.5a'), (A.5c'), (A.5d'), (A.5g') and (A.5i'). Q.E.D.

A.6 Proof to Proposition 6

If unit harvest costs are constant ( $h(R) = \lambda$ ), the intergenerational efficiency conditions (A.5c')-(A.5d')change to:

$$\alpha X^{(\alpha-1)}[1-\lambda X]^{(1-\alpha)} - \lambda(1-\alpha)X^{\alpha}[1-\lambda X]^{-\alpha} = (\phi^R + \phi_0^R)/(\phi^Y + \phi_0^Y), \qquad \text{(A.5c'')}$$

$$\phi^R g'(R) = \phi_0^R, \qquad \text{(A.5d'')}$$

while the other conditions are similar to the model without harvest cost.

Evaluating again the market equilibrium conditions at the stationary state gives (7') and (4'), $p = (q - w\lambda)[1 + g'(R)]$, $q = \alpha X^{(\alpha-1)}[1-\lambda X]^{(1-\alpha)}$, $w = (1-\alpha)X^{\alpha}$ $[1-\lambda X]^{-\alpha}$, $X^{\alpha}[1-\lambda X]^{(1-\alpha)} = C^1 + C^2$, $X^{\alpha}[1-\lambda X]^{(1-\alpha)} = C^1 + C_0^2$. Setting provisionally $q = (\phi_0^R + \phi^R)/(\phi_0^Y + \phi^Y) + \lambda w$ and again $g'(R) = \phi_0^Y / \phi^Y = \phi_0^R / \phi^R$, the stationary state market equilibrium conditions imply the intergenerational efficiency conditions (A.5a)-(A.5b), (A.5c'')-(A.5d''), and (A.5e)-(A.5i).

As in the case of no–harvest cost, the stationary market equilibrium is intergenerationally efficient only if $g'(R) = \phi_0^Y / \phi^Y > 0$, i.e. for $R \in (0, R_{\max}/2)$. Acknowledging Prop. 3, $\lambda \geq (4\alpha)/(rR_{\max})$ implies inefficiency of the stationary market equilibrium since $g'(R) < 0$. However, $\lambda < (4\alpha)/(rR_{\max})$ does not imply

intergenerational efficiency of the stationary state. The upper bound on $\lambda$ ensuring intergenerational efficiency can be obtained by solving $\mathrm{LHSL}(R_{\max}/2) = \mathrm{RHSL}(R_{\max}/2)$. The solution is $\lambda^E \equiv [8\alpha - 4(1-\gamma)r]/\{r[2-(1-\gamma)r]R_{\max}\}$ which is definitely smaller than $(4\alpha)/(rR_{\max})$. For all $\lambda \leq \lambda^E$, the stationary state market equilibrium is intergenerationally efficient (Golden Age included). Q.E.D.

A.7 Proof to Proposition 7

To evaluate the intergenerational efficiency of stationary state market equilibria with inversely stock dependent harvest cost, we rewrite the intergenerational efficiency conditions (A.5a), (A.5c), and (A.5d) by assuming that $(C_0^2)^\circ = C^2$ and $R_0 = R$.[17] As a consequence of (A.5g)-(A.5i), $g(R) = X$ and $C^1 = X^\alpha[1-\lambda X/R]^{(1-\alpha)} - C^2$. Then, (A.5a) can be written as follows:

$$\frac{C^2}{\beta\{(g(R)^\alpha[1-\lambda g(R)/R]^{(1-\alpha)} - C^2} = 1 + \frac{\phi_0^Y}{\phi^Y}. \qquad \text{(A.5a''')}$$

The condition for efficient harvest (A.5c) can be rewritten as:

$$\alpha g(R)^{(\alpha-1)}[1-\lambda g(R)/R]^{(1-\alpha)} - (1-\alpha)(\lambda/R)g(R)^\alpha[1-\lambda g(R)/R]^{-\alpha} = \frac{(1+\phi_0^R/\phi^R)\phi^R}{(1+\phi_0^Y/\phi^Y)\phi^Y} \qquad \text{(A.6)}$$

with, from (A.5d),

$$\phi_R/\phi^Y = \frac{(1-\alpha)g(R)^\alpha[1-\lambda g(R)/R]^{-\alpha}\lambda g(R)/(R)^2}{-g'(R) + (\phi_0^R/\phi^R)}. \qquad \text{(A.7)}$$

We start with the stationary market equilibrium conditions

$$C^2/(\beta C^1) = 1 + g'(R) + w\lambda g(R)/[R^2(q - w\lambda/R],$$

$$p - w\lambda g(R)/R^2 = [1+g'(R)](q - w\lambda/R),\ q = \alpha(g(R))^{(\alpha-1)}[1-\lambda g(R)/R]^{(1-\alpha)},$$

$$w = (1-\alpha)(g(R))^\alpha[1-\lambda g(R)/R]^{-\alpha}.$$

We set provisionally $\phi_0^Y/\phi^Y = g'(R) + [\lambda w g(R)/R^2](\phi_0^Y + \phi^Y)/(\phi_0^R + \phi^R)$, $q - \lambda w/R = (\phi_0^R + \phi^R)/(\phi_0^Y + \phi^Y)$ and $\phi_0^R/\phi^R = g'(R) + [\lambda w g(R)/R^2](\phi^Y/\phi^R)$. Using the latter two equations together with the first order market equilibrium conditions for $w$ and $q$ mplies the efficiency conditions (A.5a) and (A.5c).

[17] This equality settings we used, although implicitly, already in the former case of constant unit cost.

In order to obtain $\lambda^E$ and $R^E$, we assume the Golden Age and thus insert (A.7) into (A.6) under $g'(R) = \phi_0^Y / \phi^Y = \phi_0^R / \phi^R = 0$, and get after simplifying the resulting equation, $(1-\alpha)g(R^E)^2\lambda^E = -g'(R^E)R^E[\alpha R^E - \lambda^E g(R^E)]$. Solving this equation for $\lambda^E$ and inserting the results into the stationary state equation (13), we get $R^E = (\alpha R_{\max})/[(1-\gamma)r]$. By reinserting $R^E$ into $\lambda^E = [\alpha g'(R^E)(R^E)^2]/\{g(R^E)[g'(R^E)R^E - (1-\alpha)g(R^E)]\}$, $\lambda^E$ is obtained. Note that for $\phi^R / \phi^Y > 0$ in (9) it is not necessary that $g'(R) > 0$. Q.E.D.

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# MEASURING THE IMPACT OF EXTRINSIC CUES ON CONSUMERS' PURCHASING DECISION FOR FOOD PRODUCTS

**Besnik FETAI**[*]
South East European University, Tetovo, Macedonia

**Nora SADIKU-DUSHI**
South East European University, Tetovo, Macedonia

**Raman ISMAILI**
State University of Tetova, Tetovo, Macedonia

**Abstract:** The extrinsic product cues are becoming a very important aspect in product evaluation by consumers. Because of their importance many authors are exploring which extrinsic cues are considered more significant when evaluating the different kind of products. Therefore, the aim of this research is to investigate the impact of most researched extrinsic cues such as the country of origin (COO), brand, and price on a purchasing decision for food products among consumers in Kosova. To explore the domestic country bias, the impact of the additional cue labeled as "domestic product" is studied. Based on a quantitative survey, the main findings of this study revealed that the brand, the price, the country of origin, and domestic branded products have positive impact on a consumer's purchasing decision, since consumers rely on those extrinsic cues when making their purchasing decisions. When multiple cues are presented, the country of origin is considered as the most important cue, while the "domestic product" is least important to Kosovar consumers. The findings of this study are useful to food producers and marketers of food products, since it can provide them with useful information on what consumers consider most important when purchasing food products.

**JEL classification:** M31, C35;

**Keywords:** extrinsic cues, brand, country of origin, price.

[*] Corresponding author. Address: South East European University, Tetovo, Macedonia, E-mail: b.fetai@seeu.edu.mk

## 1. Introduction

The aim of this research is to investigate the impact of extrinsic cues such as the country of origin (COO henceforth), brand name, and price on purchasing decision for food products among Kosovar consumers. Many authors have conducted different studies in this field to measure the impact of extrinsic cues on consumers' perception on the quality of the products (Teas and Agarwal, 2000; Szybillo and Jacoby 1974, Miyazaki, Grewal, and Goodstein, 2005; Zeithaml, 1988; Rao and Monroe, 1989; Kirmani and Zeithaml 1993; Bredahl, 2004), risk perception (Shimp and Bearden, 1982; Aqueveque, 2006; Agarwal and Teas, 2001; Huang, Schrank and Dubinsky, 2004), product evaluation (Bilkey and Nes, 1982; Rao and Monroe, 1988) and purchase intention (Dodds, Monroe and Grewal, 1991: Grewal, Krishnan, Baker and Borin, 1998; Chu, Choi and Song, 2005; Cordell, Wongtada and Kieschnick, 1996). Price, brand (Bredahl, 2004), and COO (Al-Sulaiti and Baker, 1998) are considered to be the most studied extrinsic cues.

Despite numerous researches on the subject of extrinsic cues, there is little evidence about the impact of COO, brand, and price on consumers' purchasing decision. Since the research took place in Kosovo, apart from the chosen extrinsic cues the impact of the additional cue labeled as "domestic product" is studied.

Kosovo is a small country with an area of 10,908 $km^2$, located in Southeast Europe. According to Kosovo Agency of Statistics the approximate population in Kosovo is 1.78 million. Kosovo is a country with a negative trade balance since imports exceed its exports. Total exports for year 2016 were 309,6 million Euro while imports for the same year were 2,789.5 million Euro ("Kosovo Agency of Statistics", 2017). As most of the food products in the Kosovar market are imported, the 'cues' such as COO, brand, price, and domestic products are purposively selected for this study since Kosovar consumers must rely on those cues when making their final purchasing decision.

To fulfil the gap in the literature we attempt to answer the following research question:

1) Do extrinsic product cues impact the consumers' purchasing decision for food products?, and

2) Which extrinsic cue is considered to be the most important when making a purchasing decision for food products?

The following hypothesis will be tested:

H1: There is a significant impact of the product's brand name on the purchasing decision for food products.

H2: There is a significant positive impact of the product's price on the purchasing decision for food products.

H3: There is a significant relationship between "domestic product" brands and purchasing decision for food products

H4: There is a significant impact of the product's COO on the consumer purchasing decision for food products.

To test the research hypothesis, we applied the binary logit regression model. By adopting the quantitative research method, the data was collected by the means of a structured questionnaire, distributed to 100 respondents, based on convenience sampling.

The current study makes the following main contribution. Firstly, it explores the impact of the selected extrinsic cues on the purchasing decision, by also identifying which is the most important extrinsic cue when Kosovar consumers make their purchasing decision. Secondly, the study will try to fill at least a part of the gap in a literature regarding the extrinsic cues impact on purchasing decision. And thirdly, this study will possibly raise the interest of other scholars and researchers in developing this research field.

The paper is organized as follows: the next section presents the literature review, followed by data presentation and the research methodology. The fourth section presents the empirical analysis, while the fifth section presents the conclusions and the recommendation for further research.

## 2. Literature review

Products are the collection of attributes known as 'cues' which are used by consumers to create an impression about the specific product. Those 'cues' can be intrinsic or extrinsic (Olson and Jacoby, 1972). The intrinsic product cues are product features that are part of the product itself while extrinsic cues are not part of the product but are related to the product (Idoko et al., 2013) such as brand, COO and price (Lee and Lou, 1995), store name (Teas and Agarwal, 2000) promotion, presentation (Acebron and Dopico, 2000) warranty, manufacturer reputation (Bearden and Shimp, 1982), packaging (Mueller and Szolnoki, 2010) and advertising (Milgrom and Roberts, 1986).

Many studies found that consumers rely on product cues when they form their overall evaluation regarding different products. Product cues are defined as stimuli that play informational role before product consumption (Ahmed et al., 2004). Some studies found that extrinsic product cues can be more important than intrinsic cues, especially in initial buying where intrinsic cues are unavailable or when assessment of the intrinsic cues takes time and effort (Sawyer, Worthing, & Sendak, 1979). Therefore, according to Zeithaml (1988) the extrinsic cues are used as quality indicators when consumer has to make a decision without sufficient information on intrinsic attributes, especially in cases when the consumer has no experience with the product, has no time and has lack of interest in evaluating the intrinsic attributes or is unable to evaluate them (Zeithaml, 1988). According to literature, the most studied extrinsic cues are brand, COO, and price.

Brand as an extrinsic cue is considered a name, a term, a symbol, a sign, or a combination off all these and is intended to identify and differentiate a product or service of one seller comparing to other sellers (Kotler, Keller, Manceau, & Hémonnet-Goujot, 2015). According to Kotler et al. (2015), the brand represents a promise of the seller to deliver a set of characteristics, benefits and services to the consumer. Brand name is a very frequently extrinsic cue used to collect or keep quality perceptions and can represent a set of information about a product (Richardson, Dick, and Jain, 1994). The reduction of uncertainty is one of the most important roles that brand plays in a consumer's purchasing decision process (Auger, Devinney, Louviere, and Burke, 2010). It is also considered that brand reduces consumer confusion by acting as a signal of product quality (Erdem and Swait, 1998), moreover consumers perceive the brand as a sign of quality and then they evaluate other criteria such as packaging, price, physical appearance (Vraneševic, and Stančec, 2003). Many studies show that consumers in emerging economies rely on brand considering that common product

information are not enough reliable and available (Zhou, Su, and Bao, 2002; Maxwell, 2001). There are also several studies that explained the reasons why emerging countries rely on brands. According to Bearden and Etzel (1982), imports are usually more expensive than local alternatives and that is the reason that makes foreign brands more attractive and desirable. Hannerz (1990) observed that the desire to feel like cosmopolitan in a world that is interconnected is a reason that consumers in developing countries tend to consume branded products. Based on the previous findings in literature the following hypothesis is proposed:

H1: There is a significant impact of the product's brand name on the costumer purchasing decision for food products.

Price is also considered as an important extrinsic cue, especially when consumers do not have sufficient information about intrinsic cues, or in cases when it is the only cue that is available (Zeithaml, 1988). Many studies found that price and quality are positively related (Dodds, Monroe and Grewal, 1991; Rao and Monroe, 1989). There is a believing that consumers tend to categorize products according to price by considering that qualitative products are expensive, while lower quality products are less expensive (Acebrón and Dopico, 2000; Kardes, Cronley, Kellaris, and Posavac, 2004). Therefore, if consumers believe that price and quality are linked, paying a lower price means accepting lower quality. Contrary, to get a better quality, a consumer must be ready to make a financial sacrifice (Veale, Quester and Karunaratna, 2006). It is a real challenge for many consumers in finding a suitable balance between those two, therefore it means that price plays a significant and exclusive role in the purchasing decision (Kardes et al., 2004;). According to Veale et al. (2006), consumers tend to rely even more on price, especially in cases when they do not possess or possess limited information of product category offerings. Monroe and Krishnan (1985) found that the price is used as an important cue in cases of unbranded products and therefore it is used as information indicator when there is not enough information about the brand. The price cue is found to be used also in cases when the consumer motivation is low (Mitra, 1995). But there are also studies that oppose the statements that the price level is an indicator of quality. Bredahl (2004) in a study of cue utilization regarding the branded beef found that the price is not considered as a significant quality cue, since the beef consumers in his study do not link beef quality to the price because they consider that a very high quality beef can be sometimes found at a lower price, therefore, they do not consider the price as a reliable product cue. On the basis of the evidence that the price is considered important when making the purchasing decision, the following hypothesis is specified:

H2: There is a significant positive impact of the product's price on purchasing decision for food products.

COO as one of the extrinsic cues has been broadly studied into research literature (Dinnie, 2004). COO of the product in literature is generally defined as the country where the product is manufactured. According to Auger et al. (2010), the study of COO can be broadly divided into two categories; one that studies consumer approach toward different country products and the other that studies the domestic country product bias. The domestic country bias can be described as a consumer's preference toward purchasing domestic products over foreign products (Balabanis and Diamantopoulos, 2004), and in many studies is linked to consumer ethnocentrism

that is explained as a responsibility and morality of buying domestic products (Shimp and Sharma, 1987). According to Agrawal and Kamakura (1999) if consumers have a positive or negative image about a specific product or country they may generalize that attitude toward all the products coming from that particular country. Some recent studies have linked the COO effect with the consumer ethnocentrism which is based on the morality and responsibility of buying homemade products (Watson and Wright, 2000). Based on the above the following is hypothesized:

H3: There is a significant relationship between "domestic product" brands and purchasing decision for food products

Kotler and Gertner (2002) pointed out that the impact of COO differs depending on the type of the product. Studies on the COO impact have focused on high involvement products (ex. electronics, cars) then for low involvement products (like food and beverages) (Ahmed et al., 2004). It is found that COO is more pronounced in purchasing a high involvement product (Li and Wyer, 1994), than it is in low involvement products due to the low financial and hedonistic value for the consumer (Ahmed et al., 2004). When buying low involvement products COO does matter, but when other cues as brand and price are present the impact of COO weakens and brands becomes an important factor (Ahmed et al., 2004). Studies conducted by Peterson and Jolibert (1995) and Verlegh and Steenkamp (1999) found that the COO effect is smaller when COO is studied in multi cue research than when COO is studied as a single product cue.

Therefore, the following hypothesis is proposed:

H4: There is a significant impact of the product's COO on the consumer purchasing decision for food products.

Even though there is still no consensus among the researchers on which of the extrinsic cues are mostly important, they all agree that extrinsic cues do have an impact on the buying decision process.

Purchasing decision is one of the stages in the buying decision process. The buying decision process was first introduced in 1968 by Engel, Kollat and Blackwell known as the EKB model (Lin and Chen, 2006). According to the EKB model the buying decision is described as a continuing process which includes five stages: recognition of need, information search, alternative valuation, the purchase decision and behavior after purchase (Darley, Blankson and Luethge, 2010). These five stages are widely accepted and used by many scholars. The purchasing decision is the fourth stage of the purchase decision process, and is the stage where the actual decision to purchase or not to purchase takes place.

In this study, the purchasing decision is treated as a dependent variable with dichotomous outcome as a simple decision to purchase or not to purchase.

## 3. Data and Research Methodology

To test the research hypothesis, the quantitative research method was used. It is considered that quantitative methods are appropriate methods for studying the different phenomena in social reality, and are especially suited for hypothesis testing (Sukamolson, 2007). The other reason for choosing quantitative research approach is to determine the relation between independent and dependent variables defined in the study (Hopkins, 2008).

Given that questionnaires are found to be the most common technique for data collection in quantitative studies (Bryman, 2006), we opted for a fully structured questionnaire. Since the study took place in Kosova the questionnaire was designed in Albanian language. Before distributing it was pre –tested in a small pilot-group in order to ensure that all respondents clearly understand all the questions in the survey and they have no doubts when answering them. As suggested by Czaja (1998), the group of respondents was asked to fill the questionnaire and then they were asked if they understood the wording, phrases and questions, and, if they eventually had difficulties in answering the questionnaire. After ensuring that the questions were understandable for every participant in pilot-group, the questionnaire was personally distributed by the researcher to 100 respondents selected by convenience sampling in the city of Pristina, Gjilan and Ferizaj during a period of 30 days (June, 2017). Convenience sampling as non probability sampling technique is very frequently used in quantitative studies because it is considered as an affordable and easy technique for the researcher (Etikan, Musa & Alkassim, 2016) where samples are more accessible to the researcher (Suen, Huang, & Lee, 2014). As Dornyei (2007) suggests, it meets the criteria such as easy time availability, and geographical closeness.

The questionnaire consists of 20 questions divided in three parts: respondent's basic information (six questions: gender, place of residence, age-group, education, employment, and average monthly income), thirteen questions related to extrinsic cues and one question focused on the purchasing decision. The questions in the respondent's basic information part were closed –ended multiple choice, while the questions about the extrinsic cues were 5-point Likert-scale statements which enabled respondents to express their level of agreement-or disagreement with the respective statements. In terms of measuring the purchase decision a dichotomous (binary) measure was used by classifying the respondents' decision to (1) purchase and (0) don't purchase. It is suggested that dichotomous or binary scale is more practical especially when measuring the consumer preferences in developing countries due to the respondents' lack of knowledge and the difficulty they face in answering or giving judgments in continuous scales and longer list of stimuli (Malhotra, 1988).

To give more meaning to the collected data, the questions about extrinsic cues used in the questionnaire were grouped by their relevance into four independent variables named Brand, COO, Domestic Product, and Price. To determine the internal consistency of the new created variables, especially those using a Likert scale items it is recommended to test the reliability of scales using Cronbach's alpha (Gliem and Gliem, 2003). The reliability test results are given in the Table 1.

**Table 1. Reliability test**

| New variables | Number of items* | Cronbach's alpha |
|---|---|---|
| Brand | 3 | 0.8329 |
| Price | 3 | 0.7368 |
| COO | 4 | 0.7903 |
| Domestic_product | 3 | 0.8740 |

Source: Authors calculation

* The number of items refers to the number of questions that were grouped to form the new

Table 1 shows the values of Chronbach's alpha for all the four variables used in the study. The value of alpha ranges from 0 to 1 and it is considered that the higher the score of the coefficient, the more reliable is the scale (Santos, 1999). Since the acceptable alpha values are suggested to be in a range from 0.70 to 0.95 (Tavakol and Dennick, 2011) it is considered that all the items measured in this study are reliable and have relatively high internal consistency.

## 4. Empirical Analysis

### *4.1 Profile of respondents*

The respondent basic information covered gender, place of residence, age-group, education, employment, average monthly income. The demographic profile of the respondents is presented in the Table 2.

**Table 2. Profile of respondents**

| Description | Percentage | Description | Percentage |
|---|---|---|---|
| **Gender** | | | |
| Female | 58% | **Place of residence** | |
| Male | 42% | Village | 37% |
| | | City | 63% |
| **Age group** | | | |
| 18-25 | 18% | **Employment** | |
| 26-35 | 49% | Unemployed | 39% |
| 36-45 | 11% | Self-employed | 9% |
| 46-55 | 13% | Employed in private sector | 41% |
| above 56 | 9% | Employed in government sector | 11% |
| | | | |
| **Education** | | **Average monthly income** | |
| Primary school | 1% | Less than 200 Euro | 28% |
| Secondary school | 20% | 201-400 Euro | 33% |
| Bachelor | 65% | 401-700 Euro | 24% |
| Master | 10% | 701-1000 Euro | 8% |
| PhD | 4% | Above 1000 Euro | 7% |

Source: Authors Calculation

The data shows that 58 percent of the respondents were females. 63 percent of the total sample lives in a city. Almost half of the respondents are in the age group of 26-35 years old (49 percent). Their educational background is mostly bachelor degree (65 percent). The respondents are mainly employed in the private sector (41 percent), and average monthly income for the most of them lies between 201-400 Euro (33 percent).

### *4.2 Econometric Modelling*

Since the outcome in this study is dichotomous (measuring consumers' purchasing decision as simply "purchasing" or "not purchasing") the use of binary logit regression is seen as a most appropriate model in order to test the given hypothesis (Tranmer, and Elliot, 2008). The use of logistic regression is also seen as a very useful technique for modelling and solving problems in marketing, since many marketing problems deal with the dichotomous outcomes and this model is found to generate more suitable and accurate findings in terms of model fit and correctness of analysis (Akinci, Kaynak, Atilgan and Aksoy, 2007). The chosen sample is also suitable for performing binary logit regression based on the general rule of thumb that recommends the number of no less than 50 participants and increasing this number by adding the number of independent variables (VanVoorhis and Morgan, 2007). Green (1991) also suggested the minimum number of subjects for conducting a regression analysis should be based on this rule N > 50 + 8 m (where m is the number of predictors), which is also compatible with the number of participants in our study.

Therefore, the specification of the model is following:

$$\mathrm{Pi} = \Pr(\mathrm{Yi} = 1|\mathrm{Xi} = \mathrm{xi}) = \frac{\exp(\beta 0 + \beta 1\mathrm{xi})}{1 + \exp(\beta 0 + \beta 1\mathrm{xi})}$$

Or using a logit function this could be written as:

$$\mathrm{logit}(\mathrm{Pi}) = \log\left(\frac{\mathrm{Pi}}{1 - \mathrm{Pi}}\right) = \beta 0 + \beta i x i$$

In our case Y is a dependent variable that represents purchase decision and takes values 1 and 0 (1-when making a purchase and 0- when not making a purchase) and $X_1$, $X_2$, $X_3$ and $X_4$ are independent variables (COO, brand, price and domestic product).

### *4.3 Research Results*

The questions in all the variables were statements on a 5-point Likert scale, ranging from completely agree (1) to completely disagree (5). For the easier interpretation and data handling these responses were transformed into dummy variables. First, the mean in every variable was found and then all the responses below the mean were coded as 1 (agree), while the responses above the mean were coded as 0 (disagree). The binary logistic regression is presented in the Table 3 while its odd ratio is reported in Table 4.

**Table 3. Binary Logistic Regression Model**

| Purchase decision | Coef. | Std. Err. | Z | P>(z) |
|---|---|---|---|---|
| Brand | 2.052676 | 0.7164897 | 2.86 | 0.004 |
| Country of origin | 3.834525 | 0.9789729 | 3.92 | 0.000 |
| Domestic product | 1.829388 | 0.7350813 | 2.49 | 0.003 |
| Price | 3.18335 | 0.8801696 | 3.62 | 0.000 |

Source: Authors Calculation

*Testing the impact of brand on consumer purchasing decision.* According to the regression results shown in Table 3, the p-value that defines a good of fitness for the independent variable brand is 0.004<0.05 which shows that it is statistically significant. Since the z value for the brand is 2.86 and positively exceeds the critical value of 1.96, it can be claimed that on a confidence level of 95% the brand has a significantly positive impact on consumer purchase decision. Therefore H1 is supported.

*Testing the impact of price on consumer purchasing decision.* The p-value for the price is 0.000<0.05 shows that the statistical significance is reached. The z value positively surpasses the critical value of 1.96, therefore we can conclude that at the 95% confidence level, the price has a positive impact on a purchasing decision. Therefore, the H2 is strongly supported.

*Testing the impact of domestic products on consumer purchasing decision.* Also the domestic product variable has a p-value of 0.013<0.05 meaning that is statistically significant. The critical z value of 1.96 at a confidence level of 95% is positively exceeded which means that domestic product brands have a positive impact on a purchasing decision. Therefore, the H3 is also supported.

*Testing the impact of COO on the consumer purchasing decision.* The above results show that the p-value for the independent variable COO is 0.000<0.05 which shows that it reaches the statistical significance. The z value also positively exceeds the critical value of 1.96 and shows that at 95% confidence level, the product's country of origin has a significant impact on consumers purchasing decision; therefore, we can claim that H4 is strongly supported.

**Table 4. Odds Ratios**

| Purchase decision | Odds Ratio | Std. Err. | Z | P>(z) |
|---|---|---|---|---|
| Brand | 7.788717 | 5.580536 | 2.86 | 0.004 |
| Country of origin | 46.27145 | 45.29849 | 3.92 | 0.000 |
| Domestic product | 6.230071 | 4.579609 | 2.49 | 0.003 |
| Price | 24.12745 | 21.23624 | 3.62 | 0.000 |

Source: Authors Calculation

The importance of extrinsic cues on the purchasing decision can be also seen from the odd ratios given in Table 4, where the odds for purchasing instead of not purchasing the products based on the product brand are nearly 8 times higher in favor of purchasing. The same situation is also when deciding to purchase based on COO where odds are 47 times higher in favor of purchasing. The odds of purchasing based on a product price are 26 times higher in favor of purchasing. The lowest odds are reported in buying domestic branded products. The odds in this case are much lower than in all other extrinsic cues and are only 6 times in favor of purchasing.

The results in this study show that every extrinsic cue is important and have a positive impact on a purchasing decision. But, since this study was a multiple cue study where four extrinsic cues were presented to the respondents, following the suggestions by Azen and Traxel (2009) using a dominance analysis we have determined

the relative importance of every cue individually and their impact on a dependent variable in the logistic regression model that we used. Based on the dominance analysis presented in Table 5, COO resulted as the most important cue when Kosovar consumers make their food purchasing decisions, followed by price, brand and domestic branded products.

**Table 5. Dominance Analysis**

| Purchasing Decision | Dominance Statistics | Standardized dominance statistics | Ranking |
|---|---|---|---|
| Brand | 0.1625 | 0.2744 | 3 |
| COO | 0.2052 | 0.3465 | 1 |
| Domestic Product | 0.0475 | 0.0802 | 4 |
| Price | 0.1770 | 0.2989 | 2 |

Source: Authors Calculation

## 5. Conclusion

The main objective of this research was to explore the impact brand, price, CCO and domestic product on a Kosovar consumers purchasing decision. Besides, the other objective was to find out which of these extrinsic cue is considered most important when multiple cues are presented to consumers.

The main findings of this study revealed that the brand, price, COO and domestic branded products have positive impact on a consumer's purchasing decision. In view of the fact that kosovar consumers do rely on those extrinsic cues when making their purchasing decision and consider those cues as very important. Those findings are in general consistent with the findings from previous studies in this field.

The results show that when multiple cues are presented, consumers consider COO as most important, followed by price, brand and domestic product brands.

The most surprising finding in this study is that COO is considered as the most important cue when multiple cues are presented to the consumer, which is contrary to the studies conducted by Peterson and Jolibert (1995) and Verlegh and Steenkamp (1999) who found that the COO effect is smaller when is studied in multi cue research than when COO is studied as a single product cue. The results also are not in line with the findings of Ahmed et al. (2004), according to whom the COO is not pronounced in low involvement product such food and beverages, and the impact if COO weakens when brand and price are presented as additional cues, and the brand becomes the most important factor.

Even that domestic food brands are considered important, when presented together with other cues they are listed as the least important cue when purchasing food products, therefore the kosovar consumers may not be considered as ethnocentric, since they consider all other cues more important than domestic-labeled products.

The findings are useful to food producers and marketers that deal with production or sale of food products, since it can give them a clearer view of what consumers consider more important when purchasing food products.

This study has some limitations. Firstly, all the food products were generally examined in the study, and therefore specific food products may generate different results. Secondly, the limited number of extrinsic cues was employed. Thirdly, the study was based on the convenience sampling technique and the sample size was limited to only 100 cases therefore the findings cannot be generalized. Fourthly, the results are limited to Kosovar consumers only.

However, despite the limitations this study has opened some new insights on the impact of extrinsic cues on the consumer's purchasing decision and has offered a significant contribution to related literature by being the first study in this field conducted in Kosova.

It is recommended that in order to produce more reliable results, future studies could focus on investigating the larger sample of respondent, investigating other product cues, including other product types to the study or employing other research methodology.

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# BANKS' VULNERABILITY AND FINANCIAL OPENNESS ACROSS CENTRAL AND EASTERN EUROPE

**Simona NISTOR**[*]
Babeş-Bolyai University, Cluj Napoca, Romania

**Abstract:** This paper investigates the impact of the degree of capital account openness on banks' exposure to extreme events during the period 2005-2012 using a sample of financial institutions from Central and Eastern Europe. The empirical output highlights a positive and strongly significant impact of a higher degree of financial openness on banks' systemic vulnerability. Robust findings suggest that this harmful effect is lower for foreign owned banks or for those whose bank holding company signed one or more Vienna Initiative commitment letters. On the other side, tighter capital regulations and private monitoring policies enhance the positive impact of a higher degree of capital accounts openness on banks' vulnerability to systemic events.

**JEL classification:** G21, G28, G32

**Keywords:** banks' systemic vulnerability, financial openness**,** capital regulations**.**

## 1. Introduction

One of the most important effects generated by systemic events within the banking sector is the phenomena of contagion. Due to increased uncertainty financial shocks can propagate at an increased rate from one bank to another, making credit institutions more vulnerable to extreme events. From a macroprudential perspective, during stress periods the negative externalities transmitted through the financial network could significantly affect the stability of the financial system at the country level. Despite this severe threatening, regulatory policies are more oriented toward ex-ante prudential regulation on leverage and liquidity or restrictions on asset types and lending activities. The incorporation of network dependencies within these regulations is unsettled yet, even though the fact that they have been on the agenda of supervisory authorities in the last years.

[*] Corresponding author. Address: Babeş-Bolyai University, Faculty of Economics and Business Administration, Teodor Mihali Street, Nr. 58-60, Cluj-Napoca 400591, Romania, Telephone: +40264418652, E-mail: simona.mutu@econ.ubbcluj.ro

A major role for the propagation of extreme shocks is played by cross-border capital transactions that reflect the openness of different financial networks. There is a large strand of literature that addresses theoretically the foundations of financial networks (Allen and Gale, 2000; Freixas et al., 2000; Babus, 2016), the anticipation of interbank contagion (Dasgupta, 2004) or contagion failures (Acemoglu et al., 2015).The underlying network structure can enhance the negative spillovers among banks, particularly for the institutions with similar balance sheet exposures. Fire sales of assets by a bank, for example, may induce negative externalities to other banks holding the same assets (Adrian and Shin, 2010). As do large withdrawals of liquidity (Allen and Gale, 2007) or collateral haircuts (Brunnermeier and Perdersen, 2009). Nevertheless, the complexity of interbank risk maturity structure (Filipović and Trolle, 2013) may generate a chain reaction within the network. Another important issue is related to the fact that spillovers within the network may develop endogenously through marking to market the asset book which may induce further rounds of forced sales (Cifuentes et al., 2005).

Empirically, the identification of the effect of cross-border capital transactions openness on banks' spillovers faces a number of challenges. Existing literature do not consider the effect of regulatory framework in a country on banks' headquartered in other countries. Also, despite the amplified interest on assessing the impact of financial openness on banks' distance to default and financial stability in general, there is little empirical evidence on the impact of cross cross-border capital transactions on bank' systemic vulnerability.

We aim to fill this gap by investigating the impact of financial openness on banks' exposure to extreme events (the vulnerability of banks' market assets to a downturn in the total market assets of the system). The sample we focus on includes some of the most important banks from CEE area with a higher share in total banking assets at the country level. The years analyzed cover the period 2005-2012 when high spillover vulnerabilities have been developed as a consequence of extreme events in the financial markets. The research question we aim to answer is: *How financial openness affects the spread of contagion from the system to the banks?*

Firstly, we estimate banks' systemic vulnerability based on the distributions of banks' and system's market assets returns using Quantile Regression models. Secondly, using an Ordinary Least Square model with FE we investigate the impact of the degree of capital account openness at the country level on banks' systemic vulnerability (de jure financial openness). Thirdly, we explore the effects of ownership, Vienna Initiative commitments, capital regulations and private monitoring on the relationship between financial openness and systemic vulnerability.

The output highlights a negative impact of a higher degree of capital account openness on banks' systemic vulnerability that is strongly significant. A one standard deviation increase in the Chinn-Ito index generates about 25 percent standard deviation increase in the systemic vulnerability index. The results are robust to different specifications that account for macroeconomic environment and bank characteristics, as well as for an asymmetric extension of the systemic vulnerability index.

Empirically, our research is related to the contributions to systemic importance measures like Systemic Expected Shortfall (SES) and the Marginal Expected Shortfall (MES) proposed by Acharya et al. (2012) based on banks' undercapitalization, the countercyclical prudential regulation highlighted by the Conditional Value at Risk (CoVaR) of Adrian and Brunnermeier (2016) or the SDSVaR method (State-Dependent

Sensitivity VaR) developed by Adams et al. (2014) that reflects the contagion effects within different states of the economy. More recently, authors developed measures to identify SIFIs based on interbank positions (Drehmann and Tarashev, 2013), sovereign interlinkages (Correa et al., 2014), cross-border linkages (Minoiu et al., 2015) or network analysis (Cont et al., 2013; Hautsch et al., 2015; Betz et al., 2016). Also, this paper fits to research on regulatory incentives which highlight that financial stability can be significantly influenced by regulatory regimes (Weiβ et al., 2014), deposit insurance arrangements (Anginer et. al., 2014) or capital regulations (Bostandzic et al., 2014).

We aim to add to the literature on financial stability and financial openness. Our major contribution will reside in assessing to what extent the degree of capital account openness across CEE countries affect negative spillovers from the system to the banks. The impact of financial openness on banking sector stability has been previously investigated for both advanced and emerging economies, but the focus is on systemic contribution (the spread of contagion from a particular bank to the system during turbulent times). Our approach is different as we assess the impact on systemic vulnerability (the spread of contagion from the system to individual financial institutions). Also we explore the effects of different bank characteristics and the strength of the regulatory and monitoring framework to account for heterogeneity at the micro and macro level. In this line we add to the literature on financial stability and large foreign international groups' presence in emerging economies. To the best of our knowledge, this paper is the first that assesses the interplay between financial openness, foreign ownership status and systemic vulnerability across Central and Eastern European countries. Also, this paper provides new insights on the impact of the regulatory policies and financial openness link on banks' systemic vulnerability. Specifically, our empirical evidence emphasizes the role of tight capital regulations and restrictive private monitoring policies in controlling the exposure of banks to systemic events in countries with a lower degree of financial openness.

We proceed as follows: Section 2 provides the sample and the methodology, Section 3 describes the data, Section 4 discusses the empirical output, and, Section 5 concludes.

## 2. Sample and methodology

### 2.1. Sample

Our sample includes 25 banks that are publicly listed and represent 10 countries from Central and Eastern Europe. We started from a larger sample of more than 200 banks with data available in the Orbis database, but kept just the institutions that are listed on a stock exchange due to the requirement of market capitalization data for computing the systemic vulnerability indices. From a regulatory perspective these banks present importance at the national level, as they are classified among the top 5 banks by total assets within each country. About 70 percent of them are foreign owned and/or are part of a bank-holding company that signed one or more Vienna Initiative commitment letters.[1]

[1] Within the Vienna Initiative a number of banks from Western Europe with subsidiaries in CEE region signed commitment letters with the aim to maintain exposures in CEE banking system and support their subsidiaries during the financial crisis period.

The period analyzed covers the years 2005-2012 when high spillover vulnerabilities have been developed in CEE region as a consequence of extreme events that affected the financial markets.

### 2.2. Systemic vulnerability index

For identifying systemically vulnerable banks we will focus on one of the most popular systemic importance measures, the Marginal Expected Shortfall (MES) of Acharya et al. (2010). This permits to assess the time-varying spillovers effects from the system to a particular bank under extreme conditions and identify systemically vulnerable financial institutions. The method implies a set of variables that combines balance sheet items (Total assets and Equity) and market data (Market capitalization).

First, we compute the market assets (MA) of each bank as the book value of total assets adjusted with the ratio of market value of equity to book value of equity. Second, the dependence of each bank's market assets returns on the system's returns is expressed using the next form:

$$R^{i}_{MA,t} = \alpha^{i|sys} + \delta^{i|sys} \times R^{sys}_{MA,t} + \varepsilon^{i|sys}_{t} \quad (1)$$

$\delta^{i|sys}$ reflects the conditional dependence of bank i's return on the the system return, a large coefficient being associated with an enhanced systemic vulnerability. The estimations are run for each bank using a weekly frequency.

Running the *Quantile Regression* technique on Eq. (1) for the 1% quantile of the returns' distribution we obtain the values of the regressors that will be used to calculate the Systemic vulnerability index (SV):

$$\widehat{SV}^{i|sys}_{q,t} = \hat{\alpha}^{i|sys}_{q} + \hat{\delta}^{i|sys}_{q} \times R^{sys}_{MA,t} \quad (2)$$

### 2.3. Ordinary Least Squares estimations

This impact of the degree of capital account openness at the country level on banks' systemic vulnerability is assessed using the following empirical model:

$$Systemic\ vulnerability_{ijt} = \beta_0 + \beta_1 \times Financial\ openness_{j,t-1} + \Theta \times Bank\ controls_{ij,t-1} + \Psi \times Macro\ controls_{j,t-1} + \mu_t + \phi_i + \varepsilon_{ij,t} \quad (3)$$

The method used is *OLS Fixed Effects* with bank-level clustered standard errors. The dependent variable is the previously estimated Systemic vulnerability index of bank i from country j in quarter t (expressed in units of median % loss of the banks' market assets within a quarter). Because SV index has weekly frequency we compute the median for each bank within each quarter in order to be matched with the other regressors.

All explanatory variables are lagged one period. $Financial\ openness_{j,t-1}$ is represented by the Chinn-Ito index that measures country j's degree of capital account openness in the previous quarter. A detailed description of the bank and macro controls is given in the next section. All specifications include bank fixed effects, time fixed effects and an unreported constant. To alleviate the impact of large outliers variables are winsorized within the 1% and 99% percentiles.

## 3. Data

To answer to the main research question we employ a number of bank-level and country-level variables. The bank level variables have quarterly frequency, while the macro characteristics present yearly frequency. Their definition and data source is provided in Table 1, while their descriptive statistics are given in Table 2.

**Table 1. Description of variables**

| Variable | Definition | Measure | Source |
|---|---|---|---|
| ***Bank-quarter variables*** | | | |
| Systemic vulnerability | A measure that reflects the conditional dependence of bank i's market assets returns (1% worst outcomes) on the system's market assets return (1% worst outcomes). The indicator is estimated using Quantile Regression. Market assets are based on the book value of total assets adjusted with the ratio of market value of equity to book value of equity. | % | Author's calculations[a], Orbis |
| Asymmetric systemic vulnerability | A measure that reflects the asymmetric conditional dependence of bank i's market assets returns (1% worst outcomes) on the system's market assets return (1% worst outcomes). The indicator is estimated using Quantile Regression and distinguishes among the impact of positive and negative returns. Market assets are based on the book value of total assets adjusted with the ratio of market value of equity to book value of equity. | % | Author's calculations[a], Orbis |
| Size | Logarithm of Total assets | log(bil. Eur) | Orbis |
| Capital ratio | Equity to Total assets | % | Orbis |
| Liquidity ratio | Liquid assets to Deposits and short term funding | % | Orbis |
| Loan loss reserve ratio | Loan loss reserve to Gross loans | % | Orbis |
| Solvency ratio | Net loans to Customer short term funding | % | Orbis |
| ROAE | Return on average equity | % | Orbis |
| ***Country-year variables*** | | | |
| Chinn-Ito index | Chinn-Ito Financial openness index measures a country's degree of capital account openness. It is based on the binary variables that tabulate the restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) | units | Chinn-Ito (2006)[b] |
| Concentration | Assets of five largest banks as a share of total commercial banking assets | % | World Bank |
| Regulatory index | A composite index that reflects how tight are the regulatory and supervisory policies | units | Barth et al. (2013) |
| GDP growth | Real GDP growth | % | World Bank |
| Inflation | Change in CPI inflation, end of period | % | World Bank |

| Variable | Definition | Measure | Source |
|---|---|---|---|
| Foreign ownership dummy | Dummy variable taking the value 1 when 50% or more of banks' shares are owned by foreigners and 0 otherwise | 0/1 | Orbis |
| Vienna Initiative dummy | Dummy variable taking the value 1 if the bank i's parent signed one or more Vienna Initiative commitment letters and 0 otherwise | 0/1 | EBRD |
| Capital regulatory index dummy | Dummy variable taking the value 1 if the median of Capital regulatory index is above the median value for entire sample of banks and 0 otherwise. Capital regulatory index measures the amount of capital banks must hold and the stringency of regulations on the nature and source of regulatory capital. The index takes values from 0 to 10, higher values highlighting tight regulations. | 0/1 | Barth et al. (2013), authors' calculation[c] |
| Private monitoring index dummy | Dummy variable taking the value 1 if the median of Private monitoring index is above the median value for entire sample of banks and 0 otherwise. Private monitoring index reflects how much the regulatory and supervisory actions encourage the monitoring of banks by private investors. The index takes values from 0 to 12, with higher values pointing towards a greater regulatory empowerment of banks' private monitoring. | 0/1 | Barth et al. (2013), authors' calculation[c] |

Note: [a] Calculations are based on data from Orbis. [b] The values of the index are based on Chinn-Ito (2006) and retrieved from http://web.pdx.edu/~ito/Chinn-Ito_website.htm. [c] Calculations are based on data from Barth et al. (2013) retrieved from the World Bank Survey of Bank Regulation and Supervision (2003, 2007 and 2011).

As proxy for de jure financial openness we use the index developed by Chinn and Ito (2006, 2008) that measures a country's degree of capital account openness. It is based on the binary variables that tabulate the restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). Low restrictions on cross-border capital transactions are associated with a higher degree of financial openness. The average value of the measure across our sample is 0.77, varying from -1.86 to 2.44.

**Table 2. Descriptive statistics**

| Variable | N | Mean | Std. | Min | p25 | p50 | p75 | Max |
|---|---|---|---|---|---|---|---|---|
| Systemic vulnerability | 269 | 3.75 | 4.66 | -7.96 | 0.09 | 4.67 | 6.97 | 13.89 |
| Asymmetric systemic vulnerability | 269 | 5.75 | 8.20 | -8.41 | 2.46 | 5.58 | 8.82 | 50.56 |
| Chinn-Ito index | 198 | 0.77 | 1.06 | -1.86 | 0.06 | 0.06 | 1.38 | 2.44 |
| Size | 134 | 9.25 | 1.16 | 6.40 | 8.51 | 9.46 | 10.27 | 10.76 |
| Capital ratio | 134 | 11.17 | 3.23 | 3.93 | 8.79 | 11.11 | 13.83 | 19.11 |
| Liquidity ratio | 134 | 17.82 | 10.63 | 3.29 | 10.86 | 15.20 | 21.62 | 57.84 |
| Loan loss reserve ratio | 114 | 5.88 | 2.94 | 1.75 | 3.63 | 4.97 | 7.87 | 15.15 |
| Solvency ratio | 134 | 84.23 | 20.71 | 44.76 | 74.47 | 82.88 | 91.80 | 195.18 |

| Variable | N | Mean | Std. | Min | p25 | p50 | p75 | Max |
|---|---|---|---|---|---|---|---|---|
| ROAE | 134 | 9.31 | 8.92 | -17.35 | 4.80 | 9.97 | 14.82 | 42.98 |
| Concentration | 198 | 55.43 | 12.59 | 28.26 | 44.82 | 53.83 | 67.80 | 89.35 |
| Regulatory index | 269 | 0.63 | 0.14 | 0.46 | 0.46 | 0.59 | 0.69 | 0.90 |
| GDP growth | 198 | 5.05 | 14.63 | -50.00 | 0.00 | 8.51 | 15.25 | 29.41 |
| Inflation | 269 | 6.80 | 4.91 | -2.17 | 3.52 | 5.42 | 9.16 | 22.31 |
| Foreign ownership dummy | 269 | 0.72 | 0.45 | 0.00 | 0.00 | 1.00 | 1.00 | 1.00 |
| Vienna Initiative dummy | 269 | 0.71 | 0.45 | 0.00 | 0.00 | 1.00 | 1.00 | 1.00 |
| Capital regulatory index dummy | 269 | 5.65 | 2.23 | 3.00 | 3.00 | 6.00 | 8.00 | 10.00 |
| Private monitoring index dummy | 269 | 7.92 | 0.94 | 6.00 | 7.00 | 8.00 | 9.00 | 10.00 |

Note: This table reports the summary statistics of the dependent and explanatory variables. Definitions of variables are provided in Table 1.

Analyzing the bank characteristics, Table 3 shows that on average banks from the CEE sample have a capital ratio of about 11.17%, a liquidity ratio of 17.82%, a loan loss reserve to gross loans of 5.88%, a solvency ratio of 84.23 banks and a return on average equity ratio of 9.31%. As for the banking sector attributes, the average concentration ratio is about 55%, ranging from 28% to 89%. The regulatory index varies from 0.46 to 0.90, with an average of 0.64 across the sample. Table 3 reports the correlation among the dependent variables, financial openness index and bank controls employed in the empirical specification

**Table 3. Correlation**

| | Systemic vulnerability | Asymmetric SV | Chinn-Ito index | Size | Capital ratio | Liquidity ratio | Loan loss reserve ratio | Solvency ratio | ROAE |
|---|---|---|---|---|---|---|---|---|---|
| Systemic vulnerability | 1 | | | | | | | | |
| Asymmetric SV | 0.7920* | 1 | | | | | | | |
| Chinn-Ito index | -0.2125* | -0.4172* | 1 | | | | | | |
| Size | 0.5820* | 0.6554* | -0.1966 | 1 | | | | | |
| Capital ratio | 0.2653* | 0.2302* | -0.128 | 0.4637* | 1 | | | | |
| Liquidity ratio | -0.0202 | 0.0135 | 0.2032 | 0.1852 | 0.4349* | 1 | | | |
| Loan loss reserve ratio | -0.5052* | -0.5041* | -0.3122 | -0.2055 | 0.1478 | 0.3270* | 1 | | |
| Solvency ratio | -0.2489* | -0.2456* | 0.0367 | 0.0034 | -0.0366 | 0.0998 | 0.0003 | 1 | |
| ROAE | 0.7663* | 0.7644* | 0.1309 | 0.6648* | 0.3836* | 0.1912 | -0.4857* | -0.1219 | 1 |

Note: This table reports the correlation among the dependent variables, financial openness index and bank controls employed in the empirical specification. Their definition is provided in Table 1. * denotes significance at 1%.

## 4. Results

### 4.1. Main results

A univariate analysis of the nexus between the restrictions on cross-border capital transactions and systemic vulnerability of banks is provided in Table 4. The sample is split among banks form countries with a high degree of capital account openness (when the Chinn-Ito index is above the median value for the entire sample, Panel A) and banks form countries with a low degree of capital account openness (when the Chinn-Ito index is below the median value for the entire sample, Panel B). Panel C provides the difference in means analysis and shows a greater systemic vulnerability (that is statistically significant) for banks from countries with less stringent restrictions on cross-border capital activities. The average quarterly median exposure to systemic events during the analyzed period is about 5.57 percent loss for the high financial openness subsample, while for the low financial openness subsample the loss is about 2.32 percent.

**Table 4. Univariate analysis**

| | **A. High financial openness sample** | | **B. Low financial openness sample** | | **C. Difference in means analysis: High versus low financial openness index** | |
|---|---|---|---|---|---|---|
| Statistics | Systemic vulnerability | Asymmetric SV | Systemic vulnerability | Asymmetric SV | Systemic vulnerability | Asymmetric SV |
| N | 102 | 102 | 96 | 96 | | |
| Mean | 5.572 | 9.187 | 2.317 | 3.247 | 3.255 *** | 5.940 *** |
| Std. | 4.618 | 10.107 | 4.597 | 5.992 | | |
| Min | -6.146 | -5.952 | -7.963 | -8.405 | | |
| p25 | 4.614 | 5.010 | -0.641 | -2.298 | | |
| p50 | 6.521 | 7.506 | 2.802 | 4.061 | | |
| p75 | 8.316 | 10.969 | 5.167 | 7.856 | | |
| Max | 13.886 | 50.563 | 11.885 | 15.413 | | |

Note: This table provides the difference in means analysis of the dependent variables Systemic vulnerability and Asymmetric systemic vulnerability during 2005-2012 for the sample of banks from CEE countries with a high financial openness index (Panel A) and a low financial openness index (Panel B). Panel C exhibits the difference in means among the two sub-samples. The systemic vulnerability indices are determined using the Quantile Regression methodology and are expressed in units of median % loss of the banks' market assets within a quarter. Higher values of the indices reflect greater vulnerability to systemic events. Table 1 provides detailed definitions of the measures.

Table 5 depicts the results of the multivariate analysis. We start with a specification that accounts for bank characteristics, as well as bank fixed effects and time fixed effects (model 1). The output highlights a positive impact of a higher degree of capital account openness on banks' systemic vulnerability that is strongly statistically significant. A one standard deviation increase in the Chinn-Ito index generates about 25 percent standard deviation increase in the systemic vulnerability index. In models (2) and (3) we add the banking market concentration and the overall regulatory index to account for heterogeneity among different banking sectors. In models (4) and (5) we add additional macroeconomic controls, GDP growth and inflation. All specifications confirm the robustness of our initial findings. It is worth mentioning that controlling for more banking market and macroeconomic characteristics improve the economic significance of the output. A one standard deviation shock to the Chinn-Ito index is linked with a 42 percent standard deviation change in the systemic vulnerability index (model 5).

## Table 5. Main results: systemic vulnerability and financial openness

| VARIABLES | (1) Systemic vulnerability | (2) Systemic vulnerability | (3) Systemic vulnerability | (4) Systemic vulnerability | (5) Systemic vulnerability |
|---|---|---|---|---|---|
| *Financial openness* | | | | | |
| Chinn-Ito index | 1.111*** | 1.055*** | 1.062*** | 1.892*** | 1.866*** |
| | (0.22) | (0.34) | (0.34) | (0.50) | (0.48) |
| *Bank controls* | | | | | |
| Size | 0.045 | 0.042 | 0.007 | 0.111 | 0.173 |
| | (0.47) | (0.46) | (0.47) | (0.68) | (0.63) |
| Capital ratio | -0.209*** | -0.210*** | -0.220*** | -0.262*** | -0.261*** |
| | (0.06) | (0.06) | (0.06) | (0.07) | (0.07) |
| Liquidity ratio | 0.001 | 0.001 | 0.001 | 0.004 | 0.003 |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| Loan loss reserve | 0.054 | 0.046 | 0.047 | 0.063 | 0.060 |
| | (0.04) | (0.05) | (0.05) | (0.06) | (0.06) |
| Solvency ratio | 0.010 | 0.010 | 0.010 | 0.009 | 0.009 |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| ROAE | 0.027*** | 0.026*** | 0.026*** | 0.027*** | 0.027*** |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| *Macro controls* | | | | | |
| Concentration | | 0.007 | 0.024 | 0.026 | 0.024 |
| | | (0.04) | (0.03) | (0.04) | (0.04) |
| Regulatory index | | | 1.138 | 1.229 | 1.069 |
| | | | (0.80) | (0.77) | (0.81) |
| GDP growth | | | | 0.018** | 0.020** |
| | | | | (0.01) | (0.01) |
| Inflation | | | | | -0.016 |
| | | | | | (0.02) |
| Observations | 292 | 292 | 292 | 269 | 269 |
| R-squared | 0.391 | 0.391 | 0.395 | 0.430 | 0.431 |
| Number of banks | 25 | 25 | 25 | 25 | 25 |
| Number of countries | 10 | 10 | 10 | 10 | 10 |
| Time FE | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES |
| Cluster | Bank | Bank | Bank | Bank | Bank |

Note: This table reports the estimation results of the following empirical model:

$$Systemic\ vulnerability_{ijt} = \beta_0 + \beta_1 \times Financial\ openness_{\ j,t-1} + \Theta \times Bank\ controls_{ij,t-1} + \Psi \times Macro\ controls_{j,t-1} + \mu_t + \phi_i + \varepsilon_{ij,t}$$

The method used is *OLS Fixed Effects*. The sample includes 25 banks from 10 countries of Central and Eastern Europe analyzed during 2005-2012. The dependent variable is Systemic vulnerability of bank i's from country j in quarter t (expressed in units of median % loss of the banks' market assets within a quarter). Explanatory variables are lagged one period. All specifications include bank fixed effects, time fixed effects and an unreported constant. Variables are winsorized within the 1% and 99% percentiles, their definition being provided in Table 1. Standard errors clustered at bank level are reported in brackets.*, ** and *** denote significance levels of 10%, 5% and 1%.

### 4.2. Robustness

These section asses the robustness of the dependant variable. In what follows we replace the SV index with an asymmetric correction considering that negative returns of the system's market assets could have a greater impact in absolute terms on banks' vulnerability.

The dependence of each bank's market assets returns on the system's returns is expressed using the next form:

$$R^{i}_{MA,t} = \alpha^{i|sys} + \delta^{i|sys\,(-)} \times R^{sys}_{Market\ Assets,t} \times I_{(R^{sys}_{Market\ Assets,t}<0)} + \delta^{i|sys\,(+)} \times R^{sys}_{Market\ Assets,t} \times I_{(R^{sys}_{Market\ Assets,t}\geq 0)} + \varepsilon^{i|sys}_{t} \quad (4)$$

$\delta^{i|sys\,(-)}$ and $\delta^{i|sys\,(+)}$ reflect the conditional dependence of bank i's market assets returns on the system's market assets returns when they are negative ($I_{.<0}$) and, respectively, positive ($I_{.\geq 0}$). Large coefficients are associated with an enhanced systemic vulnerability. The estimations are run for each bank using a weekly frequency.

Running the *Quantile Regression* technique on Eq. (4) for the 1% quantile of the returns' distribution we obtain the values of the regressors that will be used to calculate the Asymmetric systemic vulnerability index (ASV):

$$\widehat{ASV}^{i|sys}_{q,t} = \hat{\alpha}^{i|sys}_{q} + \hat{\delta}^{i|sys(-)}_{q} \times R^{sys}_{Market\ Assets,t} \times I_{(R^{sys}_{Market\ Assets,t}<0)} + \hat{\delta}^{i|sys(+)}_{q} \times R^{sys}_{Market\ Assets,t} \times I_{(R^{sys}_{Market\ Assets,t}\geq 0)} \quad (5)$$

The results shown in Table 6 validate the positive impact of a higher degree of capital account openness on banks' systemic vulnerability, the economic impact being greater. A one standard deviation shock to the Chinn-Ito index produces a 50 percent standard deviation change in the systemic vulnerability index when considering the asymmetric correction (model 5).

**Table 6. Robustness check using a different proxy for systemic vulnerability**

| VARIABLES | (1) Asymmetric SV | (2) Asymmetric SV | (3) Asymmetric SV | (4) Asymmetric SV | (5) Asymmetric SV |
|---|---|---|---|---|---|
| *Financial openness* | | | | | |
| Chinn-Ito index | 2.008*** | 1.591*** | 1.600*** | 3.942*** | 3.898*** |
| | (0.50) | (0.43) | (0.43) | (1.14) | (1.11) |
| *Bank controls* | | | | | |
| Size | 0.267 | 0.248 | 0.200 | -0.277 | -0.174 |
| | (1.14) | (1.09) | (1.07) | (1.05) | (0.94) |
| Capital ratio | -0.489** | -0.504** | -0.517** | -0.595*** | -0.593*** |
| | (0.23) | (0.23) | (0.24) | (0.21) | (0.21) |
| Liquidity ratio | -0.006 | -0.006 | -0.007 | 0.009 | 0.009 |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| Loan loss reserve | -0.051 | -0.104 | -0.103 | -0.215 | -0.220* |
| | (0.05) | (0.08) | (0.08) | (0.13) | (0.13) |

| VARIABLES | (1) Asymmetric SV | (2) Asymmetric SV | (3) Asymmetric SV | (4) Asymmetric SV | (5) Asymmetric SV |
|---|---|---|---|---|---|
| Solvency ratio | 0.014 | 0.017 | 0.017 | 0.010 | 0.010 |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| ROAE | 0.021** | 0.019* | 0.018* | 0.014 | 0.014 |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| *Macro controls* | | | | | |
| Concentration | | 0.054 | 0.076 | 0.065 | 0.063 |
| | | (0.05) | (0.06) | (0.06) | (0.06) |
| Regulatory index | | | 1.546 | 0.144 | -0.121 |
| | | | (1.77) | (1.50) | (1.61) |
| GDP growth | | | | -0.010 | -0.007 |
| | | | | (0.02) | (0.02) |
| Inflation | | | | | -0.027 |
| | | | | | (0.05) |
| Observations | 292 | 292 | 292 | 269 | 269 |
| R-squared | 0.322 | 0.327 | 0.328 | 0.420 | 0.420 |
| Number of banks | 25 | 25 | 25 | 25 | 25 |
| Number of countries | 10 | 10 | 10 | 10 | 10 |
| Time FE | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES |
| Cluster | Bank | Bank | Bank | Bank | Bank |

Note: This table reports the estimation results of the following empirical model:

$$Asymmetric\ systemic\ vulnerability_{ijt} = \beta_0 + \beta_1 \times Financial\ openness_{\ j,t-1} + \Theta \times Bank\ controls_{ij,t-1} + \Psi \times Macro\ controls_{j,t-1} + \mu_t + \phi_i + \varepsilon_{ij,t}$$

The method used is *OLS Fixed Effects*. The sample includes 25 banks from 10 countries of Central and Eastern Europe analyzed during 2005-2012. The dependent variable is Asymmetric systemic vulnerability of bank i's from country j in quarter t (expressed in units of median % loss of the banks' market assets within a quarter). Explanatory variables are lagged one period. All specifications include bank fixed effects, time fixed effects and an unreported constant. Variables are winsorized within the 1% and 99% percentiles, their definition being provided in Table 1. Standard errors clustered at bank level are reported in brackets.*, ** and *** denote significance levels of 10%, 5% and 1%.

### 4.3. Further extensions

In this section we explore the effects of ownership and regulatory policies on the relationship between financial openness and systemic vulnerability. Our intuition is that the positive impact of capital account openness on banks' vulnerability could be lower for foreign owned banks and for financial institutions from countries with strong monitoring regulations.

To exploit the effects of ownership we start by constructing a dummy variable that takes the value 1 if 50% or more of banks' shares are owned by foreigners and 0 otherwise. The following empirical model is estimated using OLS Fixed Effects:

$$Systemic\ vulnerability_{ijt} = \beta_0 + \beta_1 \times Financial\ openness_{j,t-1} + \beta_2 \times Financial\ openness_{j,t-1} \times Foreign\ ownership\ dummy_{ij,t-1} + \Theta \times Bank\ controls_{ij,t-1} + \Psi \times Macro\ controls_{j,t-1} + \mu_t + \phi_i + \varepsilon_{ij,t} \qquad (6)$$

The empirical output presented in Table 7 indicates that the interaction between the Chinn-Ito index and foreign ownership dummy is negative and statistically significant at 5%. This suggests that the harmful effect of less stringent restrictions related to cross-border capital transactions on banks' vulnerability is lower for foreign owned banks.

**Table 7. Systemic vulnerability, financial openness and foreign ownership**

| VARIABLES | (1) Systemic vulnerability | (2) Systemic vulnerability | (3) Systemic vulnerability | (4) Systemic vulnerability | (5) Systemic vulnerability |
|---|---|---|---|---|---|
| *Financial openness* | | | | | |
| Chinn-Ito index | 1.826*** | 1.821*** | 1.759*** | 2.625*** | 2.637*** |
| | (0.59) | (0.55) | (0.53) | (0.75) | (0.73) |
| Chinn-Ito index × Foreign ownership dummy | -0.482* | -0.545** | -0.515** | -0.564* | -0.574** |
| | (0.24) | (0.21) | (0.20) | (0.28) | (0.28) |
| Foreign ownership dummy | -0.501* | -0.507** | -0.576** | -0.494* | -0.450 |
| | (0.25) | (0.23) | (0.23) | (0.27) | (0.29) |
| *Bank controls* | | | | | |
| Size | 0.097 | 0.092 | 0.064 | 0.231 | 0.266 |
| | (0.44) | (0.41) | (0.42) | (0.60) | (0.56) |
| Capital ratio | -0.210*** | -0.215*** | -0.223*** | -0.267*** | -0.267*** |
| | (0.06) | (0.06) | (0.06) | (0.07) | (0.07) |
| Liquidity ratio | 0.002 | 0.002 | 0.002 | 0.005 | 0.005 |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| Loan loss reserve ratio | 0.035 | 0.017 | 0.020 | 0.031 | 0.028 |
| | (0.04) | (0.05) | (0.05) | (0.06) | (0.06) |
| Solvency ratio | 0.010 | 0.010 | 0.010 | 0.009 | 0.009 |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| ROAE | 0.025*** | 0.025*** | 0.024*** | 0.025*** | 0.025*** |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| *Macro controls* | | | | | |
| Concentration | | 0.015 | 0.032 | 0.035 | 0.034 |
| | | (0.04) | (0.04) | (0.04) | (0.04) |
| Regulatory index | | | 1.184 | 1.316 | 1.200 |
| | | | (0.79) | (0.77) | (0.81) |
| GDP growth | | | | 0.022** | 0.023** |
| | | | | (0.01) | (0.01) |
| Inflation | | | | | -0.011 |
| | | | | | (0.02) |
| Observations | 292 | 292 | 292 | 269 | 269 |
| R-squared | 0.399 | 0.400 | 0.404 | 0.439 | 0.439 |
| Number of banks | 25 | 25 | 25 | 25 | 25 |
| Number of countries | 10 | 10 | 10 | 10 | 10 |

| VARIABLES | (1) Systemic vulnerability | (2) Systemic vulnerability | (3) Systemic vulnerability | (4) Systemic vulnerability | (5) Systemic vulnerability |
|---|---|---|---|---|---|
| Time FE | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES |
| Cluster | Bank | Bank | Bank | Bank | Bank |

Note: This table reports the estimation results of the following empirical model:

$$Systemic\ vulnerability_{ijt} = \beta_0 + \beta_1 \times Financial\ openness_{\ j,t-1} + \beta_2 \times Financial\ openness_{\ j,t-1} \times Foreign\ ownership\ dummy_{ij,t-1} + \Theta \times Bank\ controls_{ij,t-1} + \Psi \times Macro\ controls_{j,t-1} + \mu_t + \phi_i + \varepsilon_{ij,t}$$

The method used is *OLS Fixed Effects*. The sample includes 25 banks from 10 countries of Central and Eastern Europe analyzed during 2005-2012. The dependent variable is Systemic vulnerability of bank i's from country j in quarter t (expressed in units of median % loss of the banks' market assets within a quarter). Explanatory variables are lagged one period. All specifications include bank fixed effects, time fixed effects and an unreported constant. Variables are winsorized within the 1% and 99% percentiles, their definition being provided in Table 1. Standard errors clustered at bank level are reported in brackets.*, ** and *** denote significance levels of 10%, 5% and 1%.

Next, we assess the effects of Vienna Initiative commitments on the relationship between financial openness and systemic vulnerability. Within the Vienna Initiative a number of banks from Western Europe with subsidiaries in CEE region signed commitments letters with the aim to maintain exposures in CEE banking system and support their subsidiaries during the financial crisis period. The Chinn-Ito index is interacted with a dummy variable that takes the value 1 if the banks' parent signed one or more Vienna Initiative commitment letters and 0 otherwise. The following empirical model is estimated using OLS Fixed Effects:

$$Systemic\ vulnerability_{ijt} = \beta_0 + \beta_1 \times Financial\ openness_{j,t-1} + \beta_2 \times Financial\ openness_{j,t-1} \times Vienna\ Initiative\ dummy_{ij,t-1} + \Theta \times Bank\ controls_{ij,t-1} + \Psi \times Macro\ controls_{j,t-1} + \mu_t + \phi_i + \varepsilon_{ij,t} \qquad (7)$$

**Table 8. Systemic vulnerability, financial openness and Vienna Initiative**

| VARIABLES | (1) Systemic vulnerability | (2) Systemic vulnerability | (3) Systemic vulnerability | (4) Systemic vulnerability | (5) Systemic vulnerability |
|---|---|---|---|---|---|
| *Financial openness* | | | | | |
| Chinn-Ito index | 1.640*** | 1.709*** | 1.732*** | 2.443*** | 2.435*** |
| | (0.35) | (0.48) | (0.47) | (0.58) | (0.56) |
| Chinn-Ito index × Vienna Initiative dummy | -0.498* | -0.513* | -0.525** | -0.509** | -0.506** |
| | (0.25) | (0.26) | (0.25) | (0.24) | (0.23) |
| Vienna Initiative dummy | 0.145 | 0.137 | 0.149 | 0.118 | 0.119 |
| | (0.32) | (0.34) | (0.34) | (0.39) | (0.39) |
| *Bank controls* | | | | | |
| Size | 0.099 | 0.104 | 0.067 | 0.195 | 0.206 |
| | (0.44) | (0.46) | (0.47) | (0.64) | (0.61) |

| VARIABLES | (1) Systemic vulnerability | (2) Systemic vulnerability | (3) Systemic vulnerability | (4) Systemic vulnerability | (5) Systemic vulnerability |
|---|---|---|---|---|---|
| Capital ratio | -0.205*** | -0.204*** | -0.214*** | -0.254*** | -0.254*** |
| | (0.06) | (0.06) | (0.06) | (0.08) | (0.08) |
| Liquidity ratio | 0.001 | 0.001 | 0.001 | 0.002 | 0.002 |
| | (0.01) | (0.01) | (0.01) | (0.02) | (0.02) |
| Loan loss reserve ratio | 0.085* | 0.093 | 0.095 | 0.112 | 0.111 |
| | (0.05) | (0.06) | (0.06) | (0.07) | (0.07) |
| Solvency ratio | 0.011 | 0.010 | 0.010 | 0.010 | 0.010 |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| ROAE | 0.028*** | 0.028*** | 0.028*** | 0.029*** | 0.029*** |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| *Macro controls* | | | | | |
| Concentration | | -0.007 | 0.011 | 0.016 | 0.016 |
| | | (0.04) | (0.03) | (0.04) | (0.04) |
| Regulatory index | | | 1.230 | 1.447* | 1.416* |
| | | | (0.75) | (0.73) | (0.77) |
| GDP growth | | | | 0.016* | 0.017* |
| | | | | (0.01) | (0.01) |
| Inflation | | | | | -0.003 |
| | | | | | (0.02) |
| Observations | 292 | 292 | 292 | 269 | 269 |
| R-squared | 0.408 | 0.408 | 0.413 | 0.445 | 0.445 |
| Number of banks | 25 | 25 | 25 | 25 | 25 |
| Number of countries | 10 | 10 | 10 | 10 | 10 |
| Time FE | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES |
| Cluster | Bank | Bank | Bank | Bank | Bank |

Note: This table reports the estimation results of the following empirical model:

$$Systemic\ vulnerability_{ijt} = \beta_0 + \beta_1 \times Financial\ openness_{j,t-1} + \beta_2 \times Financial\ openness_{j,t-1} \times Vienna\ Innitiative_{ij,t-1} + \Theta \times Bank\ controls_{ij,t-1} + \Psi \times Macro\ controls_{j,t-1} + \mu_t + \phi_i + \varepsilon_{ij,t}$$

The method used is *OLS Fixed Effects*. The sample includes 25 banks from 10 countries of Central and Eastern Europe analyzed during 2005-2012. The dependent variable is Systemic vulnerability of bank i's from country j in quarter t (expressed in units of median % loss of the banks' market assets within a quarter). Explanatory variables are lagged one period. All specifications include bank fixed effects, time fixed effects and an unreported constant. Variables are winsorized within the 1% and 99% percentiles, their definition being provided in Table 1. Standard errors clustered at bank level are reported in brackets.*, ** and *** denote significance levels of 10%, 5% and 1%.

Table 8 shows that the interaction between the Chinn-Ito index and Vienna Initiative dummy is negative and statistically significant. This suggests that the positive impact of a higher degree of capital accounts openness on banks' vulnerability to systemic events is lower for banks whose bank holding company signed one or more Vienna Initiative commitment letters during the financial crisis.

Further, we exploit if the nexus among the degree of financial openness and systemic vulnerability is heterogeneous across the banking systems' capital regulatory framework. Capital regulatory index developed by Barth et al. (2008) measures the

amount of capital banks must hold and the stringency of regulations on the nature and source of regulatory capital. The index takes values from 0 to 10, higher values highlighting tight regulations. We consider the interaction of Chinn-Ito index with a dummy variable taking the value 1 if the median of Capital regulatory index is above the median value for entire sample of banks and 0 otherwise, as follows:

$$Systemic\ vulnerability_{ijt} = \beta_0 + \beta_1 \times Financial\ openness_{j,t-1} + \beta_2 \times Financial\ openness_{j,t-1} \times Capital\ regulatory\ index_{j,t-1} + \Theta \times Bank\ controls_{ij,t-1} + \Psi \times Macro\ controls_{j,t-1} + \mu_t + \phi_i + \varepsilon_{ij,t} \quad (8)$$

The results presented in Table 9 shows that the interaction between the Chinn-Ito index and capital regulatory dummy is positive and highly significant. This suggests that the positive impact of a higher degree of capital accounts openness on banks' vulnerability to systemic events is higher in countries with tighter regulations on the nature and source of capital.

**Table 9. Systemic vulnerability, financial openness and capital regulations**

| VARIABLES | (1) Systemic vulnerability | (2) Systemic vulnerability | (3) Systemic vulnerability | (4) Systemic vulnerability | (5) Systemic vulnerability |
|---|---|---|---|---|---|
| *Financial openness* | | | | | |
| Chinn-Ito index | 1.283*** | 1.235*** | 1.153*** | 1.932*** | 1.944*** |
| | (0.32) | (0.34) | (0.39) | (0.50) | (0.48) |
| Chinn-Ito index × Capital regulatory index dummy | 0.505*** | 0.487*** | 0.512** | 0.600*** | 0.590*** |
| | (0.16) | (0.17) | (0.19) | (0.21) | (0.19) |
| Capital regulatory index dummy | 0.005 | 0.174 | 0.032 | -0.195 | -0.116 |
| | (0.27) | (0.23) | (0.45) | (0.45) | (0.43) |
| *Bank controls* | | | | | |
| Size | -0.081 | -0.112 | -0.111 | 0.020 | 0.095 |
| | (0.52) | (0.50) | (0.50) | (0.70) | (0.65) |
| Capital ratio | -0.184*** | -0.193*** | -0.194*** | -0.218*** | -0.217*** |
| | (0.06) | (0.05) | (0.05) | (0.06) | (0.06) |
| Liquidity ratio | 0.002 | 0.002 | 0.002 | 0.007 | 0.006 |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| Loan loss reserve ratio | 0.072* | 0.053 | 0.053 | 0.070 | 0.066 |
| | (0.04) | (0.05) | (0.05) | (0.06) | (0.06) |
| Solvency ratio | 0.010 | 0.011* | 0.011* | 0.010 | 0.010 |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| ROAE | 0.026*** | 0.025*** | 0.025*** | 0.026*** | 0.026*** |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| *Macro controls* | | | | | |
| Concentration | | 0.025 | 0.028 | 0.038 | 0.036 |
| | | (0.03) | (0.03) | (0.04) | (0.04) |

| VARIABLES | (1) Systemic vulnerability | (2) Systemic vulnerability | (3) Systemic vulnerability | (4) Systemic vulnerability | (5) Systemic vulnerability |
|---|---|---|---|---|---|
| Regulatory index | | | 0.529 | 1.256 | 0.866 |
| | | | (1.19) | (1.43) | (1.43) |
| GDP growth | | | | 0.015 | 0.017 |
| | | | | (0.01) | (0.01) |
| Inflation | | | | | -0.022 |
| | | | | | (0.02) |
| Observations | 292 | 292 | 292 | 269 | 269 |
| R-squared | 0.415 | 0.419 | 0.419 | 0.455 | 0.456 |
| Number of banks | 25 | 25 | 25 | 25 | 25 |
| Number of countries | 10 | 10 | 10 | 10 | 10 |
| Time FE | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES |
| Cluster | Bank | Bank | Bank | Bank | Bank |

Note: This table reports the estimation results of the following empirical model:

$$Systemic\ vulnerability_{ijt} = \beta_0 + \beta_1 \times Financial\ openness_{j,t-1} + \beta_2 \times Financial\ openness_{j,t-1} \times Capital\ regulatory\ index_{j,t-1} + \Theta \times Bank\ controls_{ij,t-1} + \Psi \times Macro\ controls_{j,t-1} + \mu_t + \phi_i + \varepsilon_{ij,t}$$

The method used is *OLS Fixed Effects*. The sample includes 25 banks from 10 countries of Central and Eastern Europe analyzed during 2005-2012. The dependent variable is Systemic vulnerability of bank i's from country j in quarter t (expressed in units of median % loss of the banks' market assets within a quarter). Explanatory variables are lagged one period. All specifications include bank fixed effects, time fixed effects and an unreported constant. Variables are winsorized within the 1% and 99% percentiles, their definition being provided in Table 1. Standard errors clustered at bank level are reported in brackets.*, ** and *** denote significance levels of 10%, 5% and 1%.

Finally, the Chinn-Ito financial openness index is interacted with the private monitoring dummy. The variable takes the value 1 if the median of Private monitoring index is above the median value for entire sample of banks and 0 otherwise. Private monitoring index reflects how much the regulatory and supervisory actions encourage the monitoring of banks by private investors. The index takes values from 0 to 12, with higher values pointing towards a greater regulatory empowerment of banks' private monitoring.

$$Systemic\ vulnerability_{ijt} = \beta_0 + \beta_1 \times Financial\ openness_{j,t-1} + \beta_2 \times Financial\ openness_{j,t-1} \times Private\ monitoring\ index_{j,t-1} + \Theta \times Bank\ controls_{ij,t-1} + \Psi \times Macro\ controls_{j,t-1} + \mu_t + \phi_i + \varepsilon_{ij,t} \quad (9)$$

**Table 10. Systemic vulnerability, financial openness and private monitoring**

| VARIABLES | (1) Systemic vulnerability | (2) Systemic vulnerability | (3) Systemic vulnerability | (4) Systemic vulnerability | (5) Systemic vulnerability |
|---|---|---|---|---|---|
| *Financial openness* | | | | | |
| Chinn-Ito index | 0.897*** | 0.830** | 1.146*** | 1.888*** | 1.833*** |
| | (0.23) | (0.36) | (0.38) | (0.55) | (0.56) |

| VARIABLES | (1) Systemic vulnerability | (2) Systemic vulnerability | (3) Systemic vulnerability | (4) Systemic vulnerability | (5) Systemic vulnerability |
|---|---|---|---|---|---|
| Chinn-Ito index × Private monitoring index dummy | 0.798** | 0.819** | 1.099*** | 1.061*** | 1.087*** |
| | (0.30) | (0.34) | (0.25) | (0.25) | (0.26) |
| Private monitoring index dummy | -1.000** | -0.960*** | -2.613*** | -2.603*** | -2.599*** |
| | (0.37) | (0.33) | (0.51) | (0.52) | (0.49) |
| *Bank controls* | | | | | |
| Size | -0.028 | -0.034 | -0.193 | 0.063 | 0.149 |
| | (0.43) | (0.43) | (0.42) | (0.57) | (0.51) |
| Capital ratio | -0.208*** | -0.212*** | -0.222*** | -0.247*** | -0.245*** |
| | (0.06) | (0.05) | (0.06) | (0.06) | (0.06) |
| Liquidity ratio | 0.002 | 0.002 | 0.005 | 0.009 | 0.009 |
| | (0.02) | (0.02) | (0.01) | (0.02) | (0.02) |
| Loan loss reserve ratio | 0.031 | 0.026 | 0.015 | 0.029 | 0.024 |
| | (0.03) | (0.04) | (0.04) | (0.06) | (0.06) |
| Solvency ratio | 0.013* | 0.013** | 0.013** | 0.012* | 0.012* |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| ROAE | 0.026*** | 0.026*** | 0.022*** | 0.022*** | 0.022*** |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| *Macro controls* | | | | | |
| Concentration | | 0.009 | 0.035 | 0.048 | 0.047 |
| | | (0.04) | (0.03) | (0.04) | (0.04) |
| Regulatory index | | | 6.075*** | 6.584*** | 6.311*** |
| | | | (1.59) | (1.76) | (1.86) |
| GDP growth | | | | 0.010 | 0.013 |
| | | | | (0.01) | (0.01) |
| Inflation | | | | | -0.023 |
| | | | | | (0.02) |
| Observations | 292 | 292 | 292 | 269 | 269 |
| R-squared | 0.417 | 0.417 | 0.459 | 0.487 | 0.488 |
| Number of banks | 25 | 25 | 25 | 25 | 25 |
| Number of countries | 10 | 10 | 10 | 10 | 10 |
| Time FE | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES |
| Cluster | Bank | Bank | Bank | Bank | Bank |

Note: This table reports the estimation results of the following empirical model:

$$Systemic\ vulnerability_{ijt} = \beta_0 + \beta_1 \times Financial\ openness_{j,t-1} + \beta_2 \times Financial\ openness_{j,t-1} \times Private\ monitoring\ index_{j,t-1} + \Theta \times Bank\ controls_{ij,t-1} + \Psi \times Macro\ controls_{j,t-1} + \mu_t + \phi_i + \varepsilon_{ij,t}$$

The method used is *OLS Fixed Effects*. The sample includes 25 banks from 10 countries of Central and Eastern Europe analyzed during 2005-2012. The dependent variable is Systemic vulnerability of bank i's from country j in quarter t (expressed in units of median % loss of the banks' market assets within a quarter). Explanatory variables are lagged one period. All specifications include bank fixed effects, time fixed effects and an unreported constant. Variables are winsorized within the 1% and 99% percentiles, their definition being provided in Table 1. Standard errors clustered at bank level are reported in brackets.*, ** and *** denote significance levels of 10%, 5% and 1%.

The results presented in Table 10 shows that the interaction between the Chinn-Ito index and private monitoring dummy is positive and statistically significant. This suggests that the harmful impact of a higher degree of capital accounts openness on banks' vulnerability is greater for banks from countries with stronger regulatory and supervisory actions that encourage the monitoring of banks by private investors.

## 5. Conclusions

This paper investigates the impact of financial openness on banks' exposure to extreme events (the vulnerability of banks' market assets to a downturn in the total market assets of the system). The sample we focus on includes several of the most important banks from CEE area with a high share in total banking assets at the country level that are analyzed during the period 2005-2012. Firstly, we estimate banks' systemic vulnerability based on the distributions of banks' and system's market assets returns using Quantile Regression models. Secondly, using an Ordinary Least Square model with FE we investigate the impact of the degree of capital account openness at the country level on banks' systemic vulnerability (de jure financial openness).

The output highlights a positive impact of a higher degree of capital account openness on banks' systemic vulnerability that is strongly significant. A one standard deviation increase in the Chinn-Ito index generates about 25 percent standard deviation increase in the systemic vulnerability index. The results are robust to different specifications that account for macroeconomic environment and bank characteristics, as well as for an asymmetric extension of the systemic vulnerability index.

We also explore the effects of ownership, Vienna initiative commitments, capital regulations and private monitoring. Robust findings suggest that the harmful effect of less stringent restrictions related to cross-border capital transactions on banks' vulnerability is lower for foreign owned banks or for those whose bank holding company signed one or more Vienna Initiative commitment letters. On the other hand, the positive impact of a higher degree of capital accounts openness on banks' vulnerability to systemic events is higher in countries with tighter capital regulations and private monitoring policies.

A limitation of this study can be attributed to possible macroeconomic shocks in the home countries of parent banks with subsidiaries in emerging countries during turbulent periods. For example, macroeconomic conditions deteriorated significantly during the period analyzed in developed European countries with subsidiaries in CEE. Also bad performance at the level of bank holding company or excessive risk taking can rapidly spread to the balance sheet level of the subsidiaries, thus reducing their resilience to systemic events. An interesting topic for future research would be to assess the impact of macroeconomic shocks in the home countries of parent banks with subsidiaries in CEE region on the nexus between host countries financial openness and systemic vulnerability. Also, from a microprudential perspective, it would be useful to investigate how balance sheet shocks at the level of bank holding companies affect the relationship between financial openness and subsidiaries exposure to systemic events.

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# EVALUATION OF A CAMPUS SERVICE QUALITY RECREATIONAL SCALE

**Bakae Aubrey MOKOENA**[*]
Vaal University of Technology, Vanderbijlpark, South Africa

**Manilal Roy DHURUP**
Vaal University of Technology, Vanderbijlpark, South Africa

**Abstract:** In the past two decades, several researchers have applied service quality frameworks in sport-related domains in measuring service quality among participants. However, university campus recreation has been scarce as compared to organised sport at local, regional and national levels, which often depends on a limited tenure linked to their membership as a registered student at a university. The purpose of the study is to investigate service quality dimensions as perceived by university leisure and recreation students. A cross-sectional survey was undertaken among 301 university students using a non-probability purposive sampling. Variables that constituted campus recreation service quality were operationalised through a literature review, including sport and recreational scales. Through factor analysis, seven distinct dimensions of campus recreation service quality were established. These factors were labelled: people interaction, facility design, sociability, physical change, equipment, ambience and program range. Item total correlations show satisfactory convergence of the items within their relevant constructs. This study complements the existing recreational sports body of knowledge by exploring campus recreation service quality. These dimensions may assist campus recreation mangers to understand the dimensions that are pertinent among students within a university context better. Recreation managers, in their periodic measurement of service quality, can incorporate these dimensions.

**JEL classification**: M30, M31, M39.

**Keywords:** service quality, campus recreation programs, factor analysis, university.

[*] Corresponding author. Address: Department of Marketing & Sport, Vaal University of Technology, Vanderbijlpark, South Africa. E mail:aubrey@vut.ac.za

## 1. Introduction

Higher education (HE) is extensively considered to be part of the service industry since the orientation of its institutions is to deliver quality services to students in an increasing competitive milieu (Yeo, 2008). Universities administration and programmes are competing with various options vying for students' time in order to impact the students' development. In recent years, HEIs have realised that their academic esteem alone is not enough to appeal to the world's top students and whole academic partakers. Researchers have found that non-academic aspects of campus life can positively influence student success (Belch et al., 2001). Extracurricular programmes is another option to provide many opportunities for increasing the quality of student life on campus (Sturts & Ross, 2013). Similarly, Castle et al. (2015) alludes to at least 78% of university students being recreational facility users. This figure is expected to be higher, to date since universities not only undertake education and academic management, but also encourage their students to engage in recreational activities (Schmidt, 2017).

Traditionally, recreation was deliberated as a public good, which concentrated on outreach to susceptible people, families and communities. However, in recent times, a renewed description of recreation states that recreation is an activity willingly undertaken primarily for pleasure and enjoyment and that it flows from a feeling of well-being and satisfaction (Torkildsen, 1999). Recreation overlays with sports but also includes an assortment of other leisure activities that are not included in sporting classifications (Morris et al., 2003). It is the experience that manifests from freely chosen participation in physical, social, intellectual, ingenious and spiritual quests that enrich individual and community well-being (Canadian Parks and Recreation Association, 2015). The National Intramural-Recreational Sports Association (2014) proclaims that recreation is a vital leeway of the education process and contributes to the physical and academic development of students, enhances campus relations with campus constituencies and augments the opportunities to other participants in sport and recreational programs, services and facilities.

Campus recreation has received increased attention as recruitment, retention and satisfaction of students have become priorities for the administration of HEIs (Lindsey & Sessoms, 2006; Celik & Akyol, 2015). Recreational sport participation for university students is advantageous in a variety of ways through creation of a superior quality of campus life (Ellis et al., 2002). These include some developments in academic retention assertiveness towards learning as well as physical and mental well-being. Providing recreational programmes is critical to the overall development of mankind and often provides a vehicle to the overall educational engagement and academic achievement (Nichlos, 2007). These recreation programmes offered and the campus recreation facilities are considered as key components of a student's decision to attend a certain institution (Haines, 2001:2007, Zizzi et al., 2004, Scott, 2014). The programmes are often intellectualized as providing a site for self-control and character building (Hartmann, 2003).

Healthy institutions are societies in which students have the physical and mental well-being to conduct their academic life. Therefore, providing positive methods to develop a sense of belonging is one advantage of the healthy societies. The vital role played by recreation is captured by Young & Potgieter (2004) who posit that a lack of recreational opportunities reflects negatively on students' wellness, which can lead to greater negative social deeds such as crime and violence. In the same vein,

the researchers in this study believe that the exposition of university students to a variety of organised activities could have a positive impact on deviant behavior. An appreciation of the dimensions that constitute campus recreation programmes' patronage, may be key to student life establishments and marketers in guaranteeing operational planning activities to attract students and maximise student development.

In the past two decades, several researchers have applied service quality frameworks in sport-related domains in measuring service quality among participants. However, research on university campus recreation has been scarce as compared to organised sport at local, regional and national levels, which often depends on a limited tenure linked to their membership as a registered student at a university. Relatively few attempts, in comparison to competitive recreational programmes at a national level, have concentrated on the development of situation-specific service quality models especially in campus recreation activities. There is paucity of studies from a student's perspective with respect to motivations to join and actively partake specifically in collegiate university recreation programmes. In addition, service quality models for recreational centres tend to vary considerable by content and other researchers have seldom validated them.

Recently, there appears to be a change in university student's participation in recreational programmes due to changing lifestyles and modern technology. Today's students devote a large portion of their time in academic lectures, laboratories or at their desks; hence, the need to participate in recreational activities is paramount. Thus, it is imperative to target this segment of the population with initiatives that will encourage them to engage in physically active lifestyles.

University students also seem to be unaware of existing campus recreation facilities availability and have limited knowledge of how to use these facilities. If recreational programmes fail to meet the anticipations of participants in their search of benefits, continued participation is unlikely. The purpose of the study is to evaluate a campus service quality recreation scale within a cohort of university students through an exploration of campus service quality dimensions as perceived by university students.

## 2. Literature Review

### 2.1. Underlying theories

Astin's (1984; 1999) student involvement theory and Tinto's (1993) student integration theory serve as the two fundamental frameworks in this study. These theories were applied often across many fields related to student life. According to Astin's (1984), students' participation in extramural activities contributes significantly to the success of university students. The application of this theory to university recreation programmes suggests that high-quality programmes and high student involvement rates lead to improved learning and personal development. Studies that integrate Astin's (1984) theory of involvement with benefits associated with participation in campus recreation can corroborate the necessity and significance of campus recreation. Furthermore, Astin (1999) argues that the environmental factors influencing a student to persist or not to persist implied student participation or involvement. Participation in campus recreation programmes also consequently lead to satisfaction with academics and a logic of belonging within the campus community (Moffitt, 2010) and positive association with academic success, health and wellness (Todd et.al., 2009).

Involvement by participants in university recreation sport highly correlates with key academic indicators and positive health behaviour over time (Hackett, 2007; Huesman et al., 2009).

On the other hand, Tinto's (1993) theory of integration postulates that student's involvement in extramural activities frequently leads to interactions that integrate the students within the social system of the institution. The assumption is that partisan culture within an institution strongly affects a student's obligation and commitment to a university (Sturts & Ross, 2013). Thus, participation in campus recreation programmes can have a significant influence on the environment on campus because of the high involvement rate of the student body.

While there was a period when the evidence backing these assertions was often anecdotal, there is an increased growing body of literature that provides dependable evidence verifying the value of campus recreation programmes on university campuses (Henchy, 2013; Forrester, 2014). The implication of these two theoretical assertions is that the more recreational programmes are able to appeal, occupy and involve students, the more socially satisfied they will become in respect of their overall university experience. By using this line of reasoning, student's participation (involvement) in campus recreation programmes will assist in facilitating their integration into the quality of life as well. To this end, students who are invested in campus recreation events, are more likely to continue their education in that particular institution.

## 2.2 Service quality and the dimensions in recreational settings

More recently, researchers have advocated that service quality is indispensable to the success of sport, leisure and recreation programmes (Denison, 2013). The service quality scale (SERVQUAL) developed by Parasuraman (1985) is one of the most widely used instruments for assessing service quality. Building on the previous models of SERVQUAL, Brady and Cronin (2001) later developed the hierarchical approach model to measure service quality.

Although most of the fundamental dimensions may be conjoint across service industries, researchers approve that each service industry is unique. This is because the significant factors of quality are likely to be deliberated differently by most researchers (Garcia & Caro, 2010). Despite the relative novelty of Brady & Cronin (2001) conceptualisation, it became crucial to develop industry-specific models to fit different contexts. The usage of service quality measures explicit to recreational sport was pioneered by Osman et al. (2006) and closely followed by Ko & Pastore (2007). Against this backdrop, Ko & Pastore (2007) conceptualised a four-dimensional model of service quality for evaluating the perception of a user of service quality in respect of recreational programmes. The suggested model consists of four dimensions, namely interaction quality, physical environment quality, result or outcome quality and programme quality, with 11 sub-dimensions (espoused in Section 7) to capture campus recreation service quality.

### *Interaction quality*

This dimension refers to the mutual relation of employee-customer interface (Howat et al., 2008) and the process of providing the services (Hartline & Ferrel, 1996), which comprise attitude, behavior and expertise sub-dimensions (Brady, 1997; Brady &

Cronin, 2001). Two kinds of interaction in service delivery can occur via client-employee interaction and inter-client interaction (Ko & Pastore, 2007). Therefore, it is critical to assess both the client-employee interaction and the inter-client interaction.

### *Physical environment quality*

Several attempts to describe the effects of physical surroundings on consumers are built on research in environment psychology. This dimension refers to dominant mood, design of the facility and the available equipment (Soleymani et al., 2012) and consists of three sub-dimensions, namely facility design, ambience and equipment (Baker, 1986; Bitner, 1992; Brady & Cronin, 2001; Ko & Pastore, 2007).

### *Programme quality*

This dimension is regarded as the customers' insight of the excellence of the program (Brady & Cronin, 2001) and is defined by three specific sub-dimensions, namely the range of programme (Kim & Kim, 1995), operating time (Wright et al., 1992) and information (Howat et al., 1996; Ko & Pastore, 2007).

### *Result or outcome quality*

It should be noted that outcome does not refer to a final result but rather to the consequences experienced over a succession of service encounters (Dagger, Sweeney & Johnson, 2007). Therefore, this dimension focuses on what the consumer gains from the service and includes physical change, sociability and valence (Mazis et al., 1975; Milne & McDonald, 1999; Ko & Pastore, 2007; Khosravi et al., 2015).

## 3. Research Methodology

### 3.1. Methodology

The study employed a quantitative research design as the researcher deemed appropriate in order to use multivariate techniques to establish campus recreation service quality dimensions among university students. The cross-sectional survey approach was adopted to ensure reliability, as all participants were exposed to standard questions. Furthermore, the cross-sectional survey method was selected since it was envisaged that the use of a survey could not only make assessments more precise by enforcing uniform definitions upon the participants, but would also enable the collection of homogenous data from all the participants.

### 3.2. Sampling, data collection and sample composition

The study sample consisted of students of a university located in southern Gauteng Province in South Africa using the purposive sampling procedure. This non-probability sampling procedure was adopted in order to avoid numerous biases associated with selecting sample members from a sample frame that do not participate in campus recreation.

The fieldwork was conducted in August/September 2016 (during the normal university semester period) after ethical clearance had been obtained from the participating institution. During the collection of data, a number of ethical concerns such as the participants' right to anonymity, were adhered to. Two trained research assistants distributed the questionnaires to the participants to ensure that they were properly completed. Out of a total of 600 questionnaires distributed, 310 were useable in the final analysis (i.e. a response rate of 52% was recorded).

Of the 301 sampled respondents in this study, 57% (n=171) were male and 43% (n=130) were female. The majority of the respondents were between 18 to 25 years (n=261; 87%), followed by the age group between 26 and 33 years (n=36; 12%) and the age group between 34 to 41 years, (n=4; 1%).

The ethnicity category was dominated by Africans (n=281, 93%), followed by Coloureds (n=11; 4%), Whites (n=6; 2%) and Indians/Asians (n=3; 1%). Lastly, most participants participated in soccer (41%; n=124).

### 3.3. Measuring Instrument

A two-section self-administered questionnaire was developed to collect data from the participants. The first section of the questionnaire sought to collect information on participants' general and biographical profile such as gender and age. The second section of the questionnaire was adapted from the Scale of Service Quality in Recreational Sports (SSQRS) developed by Ko and Pastore (2005) using a seven-point Likert scale ranging from 1=strongly disagree to 7=strongly agree.

### 3.4. Reliability and Validity

Reliability was established through the computation of Cronbach alpha coefficients and composite reliabilities (CR) values. Both reliability measures were adopted with a benchmark value of 0.70 (Malhotra, 2010). The reliability for the campus recreation sub-scales displayed an acceptable level of reliability values that ranged from 0.74 to 0.86 (Cronbach alpha) and 0.74 to 0.88 (CR) respectively These results are presented in Table 1. In addition, a cut-off point of 0.50 on the item-to-total correlations was upheld as recommended by Pallant (2013).

Construct validity was established during factor analysis. The factor structure showed high factor loadings (>0.50). The construct validity of the factors were also examined in terms of convergent and discriminant validity. Convergent validity was assessed through the correlation analysis procedure. The results indicate moderate to strong correlations (r=0.250 to r=0.590) between the constructs thus displaying a confirmation of convergence. In Table 1, individual variable loading for the research constructs were from 0.529 to 0.724, therefore, greater than the recommended threshold of 0.50 (Anderson & Gerbing, 1988) showing a tolerable individual item convergence, as 50% or more of each item's variance was shared with its respective variable.

Discriminant validity was ascertained by checking if the correlations between the constructs was not greater than 0.80 (Hulland, 1999). Since none of the correlations were greater than 0.80, a satisfactory level of discriminant validity was realized. As seen in Table 1, all SV values were lower than the AVE values, further confirming discriminant validity (Fornell & Larcker, 1981).

**Table 1. Reliability and accuracy statistics**

| Research construct | | Descriptive statistics | | Cronbach's test | | CR | AVE | Shared variance |
|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Item-total | α Value | | | |
| People interaction (PIN) | $PIN_1$ | 4.37 | 1.15 | .52 | .86 | .88 | .50 | .26 |
| | $PIN_2$ | | | .53 | | | | |
| | $PIN_3$ | | | .58 | | | | |
| | $PIN_4$ | | | .63 | | | | |
| | $PIN_5$ | | | .62 | | | | |
| | $PIN_6$ | | | .57 | | | | |
| | $PIN_7$ | | | .64 | | | | |
| | $PIN_8$ | | | .58 | | | | |
| | $PIN_9$ | | | .59 | | | | |
| Facility design (DES) | $DES_1$ | 4.36 | 1.38 | .59 | .83 | .83 | .56 | .34 |
| | $DES_2$ | | | .69 | | | | |
| | $DES_3$ | | | .72 | | | | |
| | $DES_4$ | | | .64 | | | | |
| Sociability (SOC) | $SOC_1$ | 4.73 | 1.22 | .53 | .77 | .77 | .51 | .30 |
| | $SOC_2$ | | | .58 | | | | |
| | $SOC_3$ | | | .57 | | | | |
| | $SOC_4$ | | | .56 | | | | |
| Physical change (PHC) | $PHC_1$ | 4.38 | 1.50 | .71 | .84 | .84 | .64 | .30 |
| | $PHC_2$ | | | .70 | | | | |
| | $PHC_3$ | | | .70 | | | | |
| Equipment (EQU) | $EQU_1$ | 4.33 | 1.53 | .66 | .81 | .81 | .60 | .28 |
| | $EQU_2$ | | | .68 | | | | |
| | $EQU_3$ | | | .66 | | | | |
| Ambience (AMC) | $AMC_1$ | 4.50 | 1.37 | .55 | .78 | .79 | .56 | .35 |
| | $AMC_2$ | | | .63 | | | | |
| | $AMC_3$ | | | .66 | | | | |
| Programme range (ROP) | $ROP_1$ | 4.52 | 1.39 | .62 | .73 | .74 | .50 | .17 |
| | $ROP_2$ | | | .56 | | | | |
| | $ROP_3$ | | | .59 | | | | |

N.B. Mean values are based on a seven-point Likert scale ranging from 1=strongly disagree to 7=strongly agree. Cronbach alpha test statistics are derived from Reliability measures through SPSS Version 24.0. Lastly, CR, AVE and Shared variance were computed from CFA output through AMOS Version 24.0.

### 3.5. Exploratory factor analysis (EFA)

The Kaiser-Meyer-Olkin (KMO) measure and the Bartlett's test of sphericity preceded the factor analysis procedure in order to confirm whether the data were suitable for factor analysis. The KMO test yielded a sampling adequacy of 0.89, which is within the tolerable range of 0.5 and 1.0 (Malhotra, 2010) and the Bartlett's

test results yielded a significant chi-square value (p=0.000) of 4103.24 with 406 degrees of freedom. Both results confirmed that the data is suitable for factor analysis (Kaiser, 1974). Thereafter, EFA through SPSS Version 24.0, with principal component analysis (as an approach that considers the total variance in the data) and varimax rotation (to minimize the number of factors that had high loadings) was performed to evaluate the essential dimensions of service quality as perceived by university students.

The total number of factors extracted were determined using three criteria, namely factor loading (>0.50), the percentage of cumulative/total variance (>50%) and the eigenvalues (>1).

The rotated factor matrix indicating the factors and their items as well as the factor loadings are shown in Table 2. Furthermore, the naming and interpretation of the extracted factors are explained in the Discussion of Results Section.

**Table 2. Exploratory factor analysis**

| No<br>Subscale items | F1 | F2 | F3 | F4 | F5 | F6 | F7 |
|---|---|---|---|---|---|---|---|
| You can count on the employees at the university to be friendly | .53 | | | | | | |
| University employees take action when problems occur | .58 | | | | | | |
| University employees are competent | .69 | | | | | | |
| University employees handle problems promptly and satisfactorily | .71 | | | | | | |
| University employees recognise and deal effectively with the special needs of each recreational sport user | .61 | | | | | | |
| The university's customers have a positive impact on my perceptions of the university's sport recreation services | .65 | | | | | | |
| I am generally impressed with the patrons of the university | .64 | | | | | | |
| University customers follow rules and regulations | .63 | | | | | | |
| I find that the university's other customers consistently leave me with a good impression of its service. | .58 | | | | | | |
| The university's facility layout serves my purpose/needs | | .60 | | | | | |
| Impressed with the design of the university's facility | | .76 | | | | | |
| The facility is aesthetically attractive | | .79 | | | | | |
| The facility is safe and comfortable | | .61 | | | | | |
| Sense of family exist among university students | | | .74 | | | | |
| I made many friends through participating in the university's classes/programmes | | | .68 | | | | |

| No<br>Subscale items | F1 | F2 | F3 | F4 | F5 | F6 | F7 |
|---|---|---|---|---|---|---|---|
| I really enjoyed the social interaction in the university's classes/ programmes | | | .70 | | | | |
| The university's ambience is excellent | | | .57 | | | | |
| I feel that my physical fitness level has increased after having used the University's recreational sport classes/ programmes | | | | .84 | | | |
| I feel that my skill level has increased after participation in the University's recreational sport classes/ programmes | | | | .71 | | | |
| The activities that I have participated in at the university have improved my skill performance | | | | .77 | | | |
| The equipment (e.g. exercise equipment) provided by the university is up to date | | | | | .62 | | |
| A variety of up-to-date exercise equipment is available at the university | | | | | .60 | | |
| The equipment provided by the university is in good usable condition | | | | | .75 | | |
| The university's ambience is what I am looking for in a university recreational sport setting | | | | | | .62 | |
| The facility is clean and well maintained | | | | | | .75 | |
| I am consistently impressed with the facility's atmosphere | | | | | | .76 | |
| The university has various recreational sport classes or programmes | | | | | | | .76 |
| The university offers a wide range of recreational sport classes or programmes | | | | | | | .70 |
| The university offers popular recreational sport classes or programmes | | | | | | | .77 |
| Eigen value | 9.64 | 2.08 | 2.00 | 1.66 | 1.19 | 1.12 | 1.08 |
| Total variance | 33.21 | 7.21 | 6.90 | 5.71 | 4.10 | 3.82 | 3.71 |
| Cumulative variance explained | 33.21 | 40.42 | 47.32 | 53.03 | 57.13 | 60.95 | 64.66 |
| F1=People interaction; F2 Facility design; F3 Sociability;F4 Physical change; F5 Equipment; F6 Ambience; F7 Program range | | | | | | | |

### 3.6 Confirmatory Factor Analysis (CFA)

For the study, CFA using AMOS Version 24.0, was employed to ascertain the model fit **(**misfit) through indices recommended by Gaskin (2015) and appears in relevant analysis (Masmanidis, Tsigilis, & Costa, 2015) as follows: chi-square X2/df (<3.0), increment fit index (IFI>0.90) comparative fit index (CFI>0.90): Tucker-Lewis index (TLI >0.90) and the root mean square error of approximation (RMSEA<0.08).Results of the evaluation of the measurement model through showed reasonable model fit

(Table 3). The chi-square recorded a value of 1.98 which was below the recommended threshold of <3.0. The IFI, TLI, CFI and RMSEA which were 0.92, 0.90, 0.92, and 0.06 respectively, are all deemed to be satisfactory as they met the required threshold for fit measures (Bryne, 1998).

**Table 3. Goodness-of-fit statistics**

| Fit indices | CFA |
|---|---|
| Chi square | 1.98 |
| IFI | 0.92 |
| TLI | 0.90 |
| CFI | 0.92 |
| RMSEA | 0.06 |

## 4. Empirical Results

### 4.1. Correlations analysis

In order to establish the correlation between campus recreation program dimensions, non-parametric Spearman correlation tests were calculated to assess the existence of such association. This procedure was adopted because the data was not normally distributed and thus violated the assumptions of parametric data (Field 2005). The outcomes of the correlation analysis are shown in Table 4.

**Table 4. Correlation analysis**

| Factors | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| People interaction | 1.000 | | | | | | |
| Facility design | .510** | 1.000 | | | | | |
| Sociability | .431** | .547** | 1.000 | | | | |
| Physical change | .426** | .548** | .516** | 1.000 | | | |
| Equipment | .425** | .400** | .333** | .393** | 1.000 | | |
| Ambience | .492** | .590** | .435** | .515** | .514** | 1.000 | |
| Programme range | .303** | .257** | .250** | .320** | .413** | .283** | 1.000 |

**Note:** ** Correlation is highly significant at the 0.01 level (2 tailed)

### 4.2. Discussion of results

With regard to correlation analysis as reported in Table 4 , all pairs of inter-construct correlations are both significant and positive ($p<0.05$). The inter-item correlations among the campus recreation programme ranged from moderate ($r=0.250$) to strong association ($r=0.590$) among the factors. These correlations provide strong support of the interrelatedness of the dimensions of campus recreation programmes.

Table 1 reported the agreement/disagreement pertaining to the importance of each sub-dimension. Sociability (M=4.73 SD=1.22) was rated the most vital factor and explained most of the variance. The importance of range of programmes (M=4.52;

SD=1.39) and ambience (M=4.50; SD=1.37) was moderately high. Finally, physical change (M=4.38; SD=1.50), people interaction (M=4.37; SD=1.15), facility design (M=4.36; SD=1.38) and equipment (M=4.33; SD=1.50) had the lowest average respectively in importance rating, but above the neutral level.

Exploratory factor analysis (see Table 2) revealed seven factors, namely people interaction, facility design, sociability, physical change, equipment, ambience and program range. The items that loaded on the first factor labelled *people interaction*, (eigenvalue=9.64) explained 33.21 percent of the total variance and consist of nine items. This dimension of service quality support perceived recreational benefits, or the expectation thereof, that may be derived from one's leisure experiences. Furthermore, there is strong affirmation in the literature for the significance of an interactional dimension in the conceptualisation of perceived service quality (Brady & Cronin, 2001; Edginton et al., 2004; Denison, 2013; Yarimoglu, 2014). Mansor et al. (2012) captured the essence of this dimension in their assertion that interaction quality significantly influences students' satisfaction with service quality.

The items that loaded on the second factor labelled, *facility design*, (eigenvalue=2.08) explained 7.21 percent of the total variance and comprised four items that represent the service facilities layout, including practical and visually-pleasing components of the facility. In most instances, the design of a facility can occur at the front of a consumer's consciousness (Bitner, 1992) and design is one of the indicators of the perceived physical environment (Tang et al., 2001). In addition, Godbey's (2009) studies affirm that design has an effect on participation in health, recreation and wellness service settings. Taking cognizance of all aspects of the service situation during the design stage, will enable executives to track possible changes in the consumer's re-patronage intentions and ensure corporate success (Lee, 2003) as well as creating a welcoming and inclusive environment (Young et al., 2016).

The items that loaded on the third factor labelled *sociability*, (eigenvalue=2.00) explained 6.90 percent of the total variance and comprised four items that relate to positive social encounters resulting from the social gratification of being in the company of others who also delight in the same activity. The extent to which a campus recreation program supports social interaction is denoted as sociability of the location. Gao et al., (2010) provided empirical evidence to confirm the necessity of a sociability component in creating an atmosphere that is suitable and comfortable for social interaction. In addition, Lundberg et al. (2011) studies confirmed that recreation could be used as a therapeutic modality, which facilitates the development of social networks.

The items that loaded on the fourth factor, *physical change*, (eigenvalue=1.66) explained 5.71 percent of the total variance and comprised three items**.** The results from the Lagrosen & Lagrosen (2016) study confirm the role of physical change as a primary determinant of outcome quality dimension in the perception of service quality. Findings of Norman et al. (2006) provide sufficient evidence that recreational facilities variables are significantly associated to physical activity.

The items that loaded onto the fifth factor, *equipment* (eigenvalue=1.19) explained 4.10 percent of the total variance and comprised three items that incorporate the devices used to enhance the recreation experience. Consumers appraise programmes and services through physical surroundings, including equipment (Ko & Pastore, 2007). Pertinent to the literature review on equipment, consumers of recreation and leisure emphasizes on pursuing emotional fulfillment than practical usefulness from their service experience (Tang et al., 2001).

The items that loaded onto the sixth factor labelled *ambience, (*eigenvalue=1.12) explained 3.82 percent of the total variance and comprised three items that relate to the non-visual aspects of the service locality. Although ambient conditions may exist below the customer's consciousness level its importance cannot be overestimated in service delivery, since in recreational activities, consumer participate in both service production and consumption (Baker, 1986). This dimension also supports the findings of Dhurup (2014) who affirmed that ambience impacts patrons' evaluation of a service and intentions to patronise the facility in future. Furthermore, the ambient dimension of the physical service surrounding acts as a package by transmitting a total image in terms of probable usage and absolute quality of the service.

The items that loaded onto the seventh factor, labelled *program range*, (eigenvalue=1.080) explained 3.726 percent of the total variance and includes three items that refer to the variety and attractiveness of programmes offered to participants. Programming offered through campus recreation is positioned to assist HEIs in promoting a greater sense of community development and sound relationships.

## 5. Conclusion and Recommendations

The field of recreation is evolving on a daily basis and recreation has been an integral part of HE for decades. HEIs who focus on leisure and recreation, in addition to the primary services offering, have the greatest opportunity of maximising current and longtime benefits. Overall, this study's measurement outcomes were acceptable in terms of reliability and validity; although, there is certainly a need for supplementary work to validate the instrument. The attractiveness of university recreation and sport programmes could be used as a marketing tool to potential students to the campus.

The service quality dimensions identified need to be incorporated by recreation managers in their periodic measurement of service quality. These dimensions can additionally serve to inform practitioners of how best they can support students and enhance their development. Furthermore, the validated measuring instrument should be employed as an analytical methodology to uncover broad areas of sport and recreation center service quality and shortfalls. In addition, the findings of this study can be used by campus recreation program coordinators to defend the existence of their programmes and structure them in a manner that would produce the greatest benefits for the students. The attractiveness of the university recreation and sport programmes could be used as a marketing tool to prospective students to the campus.

Recreation sport program administrators should contemplate on further evaluation of the wants and needs of their clients to see if a change in programme operation is needed. In this regard, the outcomes of the study should assist university recreational sport professionals to document their impact on students' development and assist the entire campus community in understanding the role campus recreational programmes play in the broader mission of the university. The university recreational officers should consider all these factors as indispensable aspects for the success of campus recreation programmes.

The outcomes of this study need to be qualified in view of the limitations. Firstly, the study adopted a non-probability convenience sampling method, which does not provide for an objective valuation of the exactness of the sample finding (Malhotra, 2010). It is therefore recommended that future research in this context, include using

probability sampling.The use of quantitative methods only and depending solely on cross-sectional data as source of information, when attempting to validate the measuring instrument may be a limitation. To this end , the use of both quantitative and qualitative research, such as structured interviews, is encouraged as it will afford an opportunity to gather richer data and greatly support the findings of the study. The developed scale could also be applied to a longitudinal study to explore how consumers' perceptions and evaluation of service quality adjusts over time.

Secondly, the psychometric properties of the measuring instrument have been confirmed with a limited sample of students from one university. Further tests of psychometric properties of the measurement instrument using broader samples in other contexts could be appropriate to increase the confidence level in the usage of the scale.

Thirdly, the study was undertaken in a university situated in the southern region of Gauteng in South Africa, therefore, it would be unrealistic to generalise the findings in other HEIs. In future, the study can be extended to other regions and provinces in order to undertake comparative studies in service quality dimension within a sport and recreation context.

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# UNDERSTANDING SUCCESS ACCORDING TO CROWDFUNDING PROJECT'S INITIATORS

**Susana Costa e SILVA**[*]
Católica do Porto Business School, Porto, Portugal

**Ana Isabel Tavares VIEIRA**
Católica do Porto Business School, Porto, Portugal

**Abstract:** Over the past few years, a large number of projects related to entrepreneurship ideas have appeared daily in the media, due to the fact that they were sold as new solutions for companies or gave origin to new companies. These projects were mainly created by individuals who were students, unemployed persons or working people and, consequently, did not have a company of their own and, in most of the cases, also did not have the means to finance their idea. In some situations, the creation of a crowdfunding project presents itself as a convenient and riskless option for funding and this is frequently the reason why some project initiators decide to launch a campaign. The assessment of each campaign depends on the expectations of the project creator, who is in the best position to decide whether it was actually successful. Untangling how a project owner can assess the performance of its project is of major importance, namely when projects are launched by individuals who ultimately carry all the tasks involved in the initiative. This is a field of research within crowdfunding that remains, to the best of our knowledge, under researched. We propose a framework for the analysis of the success of these projects and we test it on six crowdfunding projects launched in Portugal. Our goal is to shed light to the factors that can be used by project creators in the assessment of the performance of their initiatives.

**JEL classification:** O22

**Keywords:** crowdfunding, project owners, success, goals.

[*] Corresponding author. Address: Católica do Porto Business School, Rua Diogo Botelho, 1327, 4169-005 Porto – Portugal, phone: + 351 22 619 6200, E-mail: ssilva@porto.ucp.pt

## 1. Introduction

According to Howe (2006), crowdfunding is a concept derived from crowdsourcing that regards tasks that were formerly performed in-house and that are outsourced to a large unknown group of people in a form of an open call. Over the last years, crowdfunding has been gaining visibility as an alternative financing tool in relation to traditional methods, in a time where entrepreneurship and new ideas are increasingly a means to create businesses. Crowdfunding campaigns bring together a unique community of people who share an interest and are willing to donate their own money to support an interest. There are currently several platforms that assist in this goal. Some are reward-based platforms (such as Indiegogo and Kickstarter), which are the most well known. However, we can also have equity-based ones such as Seedrs and GrowVc, which are becoming popular as well, especially after President Obama used it in the JOBS act of 2012. At the end of 2017, Kickstarter reported to have in its track record over than 137,171 projects and 3.5 billion dollars pledged (Stemler, 2013).

In this scenario, these platforms appear as good alternatives for raising the funds necessary to turn an idea into reality. Obtaining financing from a bank or using personal or family savings to fund a project may involve risks that crowdfunding initiatives don't bear (Schwienbacher & Larralde, 2010). For a bank loan, it is necessary to provide some type of guarantees that sometimes do not exist and using own savings may also be unreasonable if no savings exist. There are alternative ways of financing: one way involves dealing with crowdfunding. Although this method is not new, with the development of Web 2.0, which is characterized by greater interactivity and cooperation on the part of users, more pervasive network connectivity and enhanced communication channels, it became visible for a larger number of users. In a first approach, we can say that what makes crowdfunding exciting and appealing is its riskless impact (Calvo, 2015) and inherent advertising (Golić, 2014). However, other outputs from these initiatives should be put forward by project owners, which deserve investigation. The main goal of this paper is to understand the factors which contribute to the success of the phenomenon crowdfunding from the point of view of the project owner. In other words: we want to understand the meaning of realization when crowdfunding is used and which factors contribute to explain its success.

Considering that before presenting and discussing crowdfunding as a method for financing projects or ventures it is advisable to understand how the crowdfunding phenomenon has been dealt with in a scientific context, an interlinked brief literature review is organized and discussed in the next section. After this, we will present the methodology followed. In the next section, the sample group and the approach to the study are discussed and the rationale behind the chosen methods is assessed. The result of interviews, motivations and the meaning of realization for the project creators are presented after, with special focus on some points in common which contribute to and enrich crowdfunding studies, namely the impact of communication and market tests in the definition of success and the long-term benefits of crowdfunding. This is the backbone of our conclusions. Finally, all the major findings are discussed and summarized, and the limitations of this study are identified.

## 2. Theoretical Background

### 2.1. Web 2.0 and Crowdsourcing

The evolution of the networked world at the beginning of this century led to the emergence of *Web 2.0* in replacement of web 1.0. Basically, with the appearance of *Web 2.0*, web-based applications began to rely on and be influenced by content generated by users instead of being rigid, which consequently involved market changes. Constantinides & Fountain (2008) define *Web 2.0* as a collection of open-source, interactive and user controlled online applications expanding the experiences, knowledge and market power of the users as participants in business and social processes. *Web 2.0* applications support the creation of informal users' networks, facilitating the flow of ideas and knowledge. This promotes efficient generation, dissemination, sharing and edition/refinement of informational content. It is based on three main principles: focus on service-based, simple and open-source solutions in the form of online applications; continuous and incremental application development requiring the participation and interaction of users in new ways: not only consuming but also contributing, reviewing and editing content; and new service-based business models and new opportunities for reaching small individual customers with low-volume products.

The development of *Web 2.0* has been identified as an explanation to the quick proliferation of many phenomena in business, such as *crowdsourcing*. Indeed, some authors (e.g. Kleemann et al., 2008) consider *Web 2.0* a prerequisite to the existence of crowdsourcing. In 2006, Jeff Howe introduced the term *crowdsourcing* to refer to the act of outsourcing a task to a crowd, for the purpose of explaining why several organizations have implemented online systems which gather ideas for new products and services from a large, dispersed "crowd" of non-experts. It is the act of taking a task traditionally performed by a designated agent (such as an employee or a contractor) and outsourcing it by making an open call to an undefined but large group of people (Howe, 2008).

Another term was used by Kleemann et al. (2008) to refer to this emerged tool: *working consumer*. Although being quite similar to crowdsourcing, he emphasizes a figure that actively takes part in the production process and replaces a former need for employees to perform specific tasks, creating value. These working consumers' capacities, or consumers' experiences, are valuable economic assets and are integrated into corporate structures, and their actions can be monitored as regular employees.

Crowdsourcing is a matching between knowledge, talent and those who need it to continue to upgrade their ideas and business (Howe, 2008). The crowd could be asked to contribute with new ideas for products and services, to develop solutions to a specific problem or even to use their own money to finance the development of a new business. One of the best examples of crowdsourcing is the Innocentive Platform, where companies such as NASA and The Economist launch challenges to a network of millions of problem solvers. These companies partnered with InnoCentive to rapidly generate innovative new ideas and solve problems faster, more cost effectively and with less risk than ever before. Innocentive describes its methodology, Challenge Driven Innovation, as an "innovation framework that accelerates traditional innovation outcomes

by leveraging open innovation and crowdsourcing along with defined methodology, process, and tools to help organizations develop and implement actionable solutions to their key problems, opportunities, and challenges"[1].

### 2.2. What is crowdfunding?

As claimed by Jeff Howe in his 2008 article, "(…) crowdfunding isn't new. It's been the backbone of the American political system since politicians started kissing babies. The Internet so accelerates and simplifies the process of finding large pools of potential funders that crowdfunding has spread into the most unexpected nooks and crannies of our culture" (p. 7). As Howe mentioned, the Internet has been the facilitator, so this practice became more than an informal act.

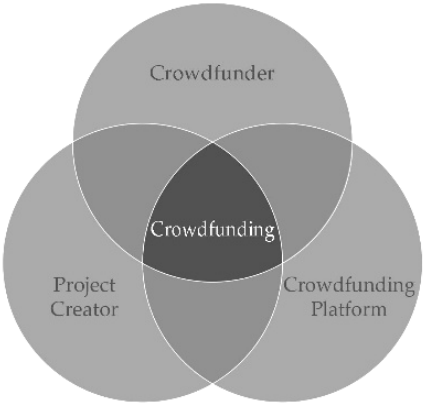
Ordanini (2009) refers to crowdfunding as a collective effort by people who network and pool their money together, usually via the Internet, in order to invest in and support efforts initiated by other people or organizations; Schwienbacher & Larralde (2010) suggest a rather similar definition: it involves an open call, essentially through the Internet, for the provision of financial resources either in form of donations (without rewards) or in exchange for some form of reward and/or voting rights in order to support initiatives for specific purposes. Whitla (2009, p. 15) propose a similar idea: "Crowdsourcing is a newly developed term which refers to the process of outsourcing of activities by a firm to an online community or crowd in the form of an 'open call'. Any member of the crowd can then complete an assigned task and be paid for their efforts." These definitions call our attention to the importance of open innovation (Chesbrough et al., 2006) and there are in fact authors that study the connection between both phenomena (see, for instance, Hopkins, 2011 and Carpenter, 2011).

The amplitude of areas in which the crowdsourcing and crowdfunding phenomena can be applied is vast, no matter what definition is used. In fact, all definitions converge to a method of financing projects through a public appeal, via the Internet. Although this definition is consensual and used by many researchers in this area, Gerber & Hui (2013) consider that the definition is too focused on the exchange of funds. When studying motivations from both creators and crowdfunders, evidence was presented strongly suggesting that participants exchange resources with the goal of learning from and connecting with others; therefore, we cannot explain this phenomenon only in relation to monetary contributions.

When characterizing the crowdfunding phenomenon, it is important to identify its participants: 1) Crowdfunder: someone who contributes financially to the projects of others; 2) Project owner: someone who creates a project/has an idea and wants financial support; and 3) the Crowdfunding platform: online site where information is available and promoted for all the parties (Figure 1).

[1] In https://www.innocentive.com/new-book-by-innocentive-executives-unveils-the-challenge-driven-enterprise/, retrieved in 29/12/2017.

**Fig. 1. Crowdfunding parties**




***Forms of crowdfunding***

Although this is a recent field of study, the crowdfunding phenomenon has been studied from different perspectives, in an attempt to understand its importance and impact. Two different approaches can be considered: one regarding what contributors are expecting to achieve with their contributions (funding's' form) and another one regarding the moment when it occurs. Based on what supporters are expecting to achieve with their contributions, four types of crowdfunding can be identified, which are consensual and have been mentioned by many authors (e.g. Leite (2012); Rodrigues (2014); Santos (2015)):

- *Equity-based crowdfunding*: individuals who invest in this type of crowdfunding model expect, when the campaign achieves the desired final amount of financing, the right to detain a percentage of the company's equity.
- *Lending-based crowdfunding:* the amount of money invested by crowdfunders returns to them within a given period of time, established when the campaign was launched.
- *Reward-based crowdfunding:* crowdfunders receive a reward depending on the amount invested. The set of rewards is presented with the project and works, usually, according to different levels: the more you donate, the more you will receive. Sometimes it is a pre-sale of the product or service that is being created. This is the most common type used by crowdfunding platforms.
- *Donation-based crowdfunding:* the funds are collected by donation and consequently supporters are not expecting any return on that particular investment. This is usual when funding charitable projects or non-profit organizations.

Although it is not used by any platform, a fifth type has been proposed by Leite (2012), which enhance another important viable solution. It will be included here, regarding to its relevance.

- *Hybrid-based crowdfunding:* it results from a combination of one of the previously mentioned types with another financing method. This source of financing (e.g. personal savings, bank loan) provides a substantial percentage of the total amount needed in combination with one of the other types of *crowdfunding* (Leite, 2012).

Each project creator should analyze which one matches the project goals and understand whether the crowdfunding platform that he is planning to use operates in the way sought. This may change from country to country. In Portugal for instance, the law only permits two types of crowdfunding to be operated: donation-based and reward-based. However, the two main Portuguese platforms (PPL and Massivemov) only use the reward-based system, because it has been proved that reward has an important role in individuals' motivations to contribute.

Regarding the contributors' objective when donating money to a crowdfunding campaign, Kappel (2009) has introduced two kinds of crowdfunding: ex-ante and ex-post crowdfunding. He distinguishes them as follows: *ex-post crowdfunding* occurs where financial support is offered in exchange for a completed product; *ex-ante crowdfunding* happens when financial support is given on the front end to assist in achieving a mutually desired result. This second type assumes that it is necessary to achieve a goal for launching or not launching the project.

### *Motivations*

Another topic that raises researchers' interest is the motivation to use crowdfunding as a financing method. As crowdfunding is composed by project creators and donators, it is important to separate what motivates each party to participate. As regards what drives crowdfunders to participate, Harms (2007) considers that it seems necessary to merge social, economic and psychological perspectives to achieve a comprehensive understanding of consumers' motivations to invest in a crowdfunding project. Gerber et al. (2011) argue that funders are motivated to participate in order to seek rewards, to support creators and causes, and to strengthen connections with people in their social networks. Generally, participation may have a significant effect on the economy by encouraging a more diverse set of people to start small entrepreneurial ventures, influencing the ideas that are introduced into the world. Extant research shows that contributors desire to collect external rewards, such as an acknowledgment, a tangible artifact, or an experience. They are also motivated to increase their funding amount to get a desired reward (Gerber & Hui, 2013).

With regard to what drives project owners to use crowdfunding as a financing method, creators are motivated to participate for raising funds, receiving validation, connecting with others, replicating successful experiences of others and expanding awareness of their work through *social media* (Gerber & Hui 2013). The crowdfunding itself is based on constant feedback and incentives that can determine the future directions of the project. Rodrigues (2014) highlights the evident advantages in cost-efficiency and learning processes of using crowdfunding.

### *Success*

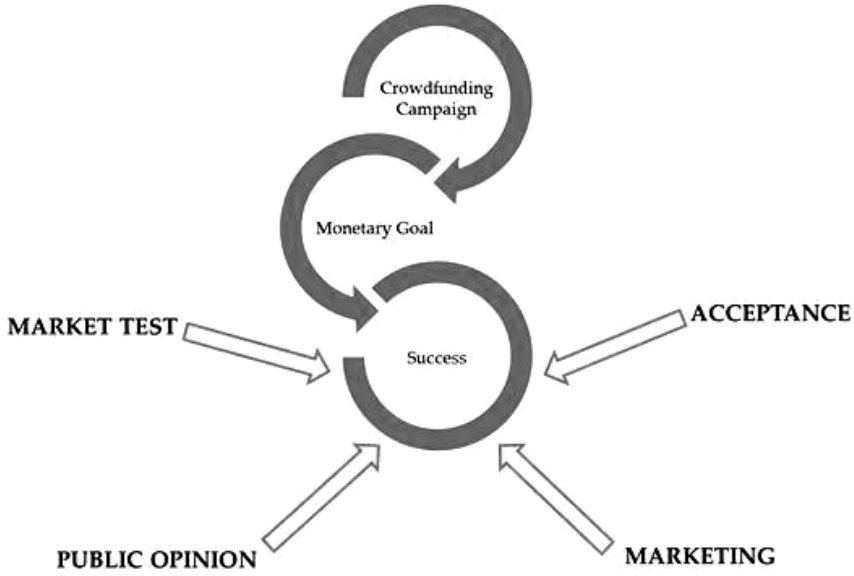
Although project owners have motivations to use crowdfunding to finance their projects and donators respond to the appeal to contribute, it is important to define some factors in order for a campaign to achieve success. For the purpose of this study, success is considered to the level of satisfaction project owners perceive in their projects. It is then a subjective measure, which is supposed to reflect the individual contentment with the project, after the crowdfunding campaign has taken place. Leite (2012) has identified some factors which contribute to the success of crowdfunding campaigns, such as planning the project properly and making sure that when it is presented to the public it is sufficiently clear and attractive. He also mentions the important role played by rewards as a motivational factor: rewards are normally the main reason that leads people to invest. This way, it is very important for successful projects to offer tangible rewards in exchange for contribution. Additionaly the author also refers the importance of enrolling consumers: communication has crucial influence, being carried out by video means, by a written description of the initiative, and/or by updates provided during the process.

Some types of crowdfunding have been proved to be more successful. Matos (2012) analyzed the relationship between the type of incentive that a platform chooses to incite users to invest and the impact that it has on the total amount of money raised by that platform. Prizes are the most popular form of incentive on platforms. However, platforms that use this type of incentive raise, on average, less money per year than interests, donations and equity platforms. Nevertheless, we can say that despite the contribution of the just mentioned studies, there is still a lack of investigation concerning the connection between project creators' motivations and the success of campaigns.

From the literature reviewed, it is possible to determine that, even if the majority of the first crowdfunding platforms were created for charity purposes and used the donations model (Matos, 2012), crowdfunding emerged and was spread out as a financing method. According to Gerber & Hui (2013), what drives project creators to initiate the projects is their motivation to use platforms due to its ease of use, and to its efficient and organized way to solicit and collect financial support from many people in a dispersed network (see Figure 2). The *need to collect money* and the achievement of the proposed monetary goal leads to the success of the online campaign. However, there seems to exist other relevant objectives that, once achieved also contribute for the overall satisfaction with the crowdsourcing experience by the project' creators. As a matter of fact, the need to communicate (the idea to the public) is also pointed out in the previous study – *Public Opinion and Marketing* – as well as the need for validation – *Market Test and Acceptance*. The fact that a significant number of people believe in a business to the point that they put their own "skin in the game" is a powerful sign that it will do well on the market (Matos, 2012).

Even though the most relevant objective in a crowdfunding project is the achievement of a monetary goal, we can also expect other objectives attainment to be part of the overall satisfaction with the project at the end. This way, we propose a model in which, after the monetary goal, project owners perceive their satisfaction on the basis of four other pillars relating non-monetary objectives, as proposed in the model of the following figure (Figure 2).

**Fig. 2. Project owners' factors for assessing satisfaction**




## 3. Methodology

Considering that the goal of this study was to identify and understand individual's perception of success, we decided to use a case study as a method; and, to obtain data, a qualitative approach was considered to be the more suitable approach. According to Yin (1994), qualitative data analysis can play an important role in understanding and resolving business problems: according to that author, qualitative data analysis can be especially helpful in the areas of initial discovery and preliminary explanation of the marketplace as well as in assessing customer behavior and decision processes. The main goal of our interviews was to understand, through the experience of the project creators, how different motivations should be interwoven to achieve success.

The use of in-depth interviews was the chosen technique since, when used properly, this method allows for the interviewee to detail any given topic as much as possible. Interviews enabled us to obtain unrestricted and detailed comments, including feeling, beliefs and opinions, which enrich the analysis (Yin 1993).

### *Sample and procedure*

We interviewed six subjects whose campaigns have already ended; when the subject was an organization, the interview was made to a representative of that organization. More details about projects are shown below (Table 1). The following discussion topics have been addressed: a) reasons for choosing crowdfunding, b) the meaning of success, c) how the campaign was assessed and, when the monetary goal was not achieved, what they would change.

The interviewees were chosen from both the PPL and the Massivemov Platforms, since these two platforms represent the majority of the population of Portuguese crowdfunding campaigns. Projects were chosen taking three criteria into consideration:

1) the nature of project – we wanted to include as many areas as possible, in order to introduce a variety of ideas;
2) their timing - projects had to be online between 2014 and 2015 (recent projects, so it was easier to obtain contacts);
3) the availability of the project creators to cooperate with the present study.

The first contact with the interviewees was made by email; fifteen project owners were contacted. In this first contact, the main goal of this study was explained and, after their acceptance, the interview was conducted, in Portuguese, by phone or via Skype call. Each interview lasted for around 45 minutes.

**Table 1. Interviewees Information**

| Campaign (Platform) | Area | Contact Person | Monetary Goal | Achieved Amount | Supporters | Facebook page |
|---|---|---|---|---|---|---|
| Quase um Doutoramento **(PPL)** | Science/ Technology | Sílvia Lino | 750 € | 1.136 € | 52 | facebook.com/PPLquasedoutoramento.mar |
| BeeSweet **(MassiveMov)** | Innovation | Ana Pais | 10.000 € | 1.375 € | 40 | facebook.com/www.beesweet.pt |
| Lusitiny **(PPL)** | Entrepreneurship | Carolina Marques | 3.150 € | 3.255 € | 18 | facebook.com/upwooding |
| Pictomed **(PPL)** | Social | Romina Fernandes | 1.000 € | 1.095 € | 34 | facebook.com/Pictomed |
| Liquen Boards **(MassiveMov)** | Sports | Paulo Pinheiro | 8.000 € | 1.400 € | 14 | facebook.com/LIQUENBoard |
| BeeRural **(PPL)** | Entrepreneurship | Raquel Alves | 3.000 € | 3.099 € | 53 | facebook.com/BeeRural.PT |

## 4. Results

### *Motivations to use crowdfunding*

The reasons presented by the project initiator for using crowdfunding are in line with the motivations already described by previous research, namely, as we can see next, collect money, communicating the projects and its underlying ideas, test the market for the products/services or ideas, and respond to existent contests.

#### Collect money

> *"We had the idea of developing a crowdfunding campaign because our project was in an initial stage and needed financing. In Portugal, there are few options for financing projects in earlier stages, such as ours." – Pictomed*

> *"Our finances were compromised and, according to an online research we made, crowdfunding was the only way available to collect the money we needed in order to participate in InvestJovem…" – BeeRural*

Online campaigns are normally based on monetary goals, which mean that during the time frame in which the campaign is online, it is supposed to appeal to contributors to achieve those goals. In order to have a successful campaign and develop their projects, project creators need to raise a certain amount. It is important to point out that crowdfunding seems to be an easy way for projects in an early stage to collect money, which is normally the primary objective of the campaign. As this objective is set in a shape of a certain figure, its achievement is normally easy to confirm.

**Communicate the project**

> *"We did not increase our sales significantly, but we created awareness for our project which was extremely positive." - Liquen Boards*

> *"We decided that it would be an interesting way to advertise our project; it also made us think more seriously about the presentation of the project and how we should present our principles and our ideas; so we proceeded with the crowdfunding campaign. (…) Through the platform we were able to be interviewed a few times, namely with journalists and certain magazines. We even had a magazine we did not know about sending us a copy of an article they wrote about us, the project and the crowdfunding campaign" - LusiTiny*

> *"Since it is a public appeal, it is also a way to advertise. It reaches more people. The difficulty [of financing the printing of PhD thesis] does not affect me alone; a lot of students, like me, had [their grants] cut. I thought that it was a way to cause a stir" – Quase uma tese Doutoramento*

Project creators benefit from the public exposure of the online campaigns. This supports the findings of previous research, which revealed that crowdfunding creators are given the opportunity to market their projects to the general public through social media and popular press (Gerber & Hui, 2013).

A long-term impact, that highlights the existence of positive unexpected impacts, was also identified in our sample. The level of advertisement achieved during the crowdfunding campaign sometimes lead to regular contacts with third parties, namely new business partners, which is obviously an interesting outcome as well.

> *"… Some articles were published. The magazine, which was published this month, mentions the campaign, and the campaign already ended last month. It cannot help the campaign anymore, but it helps promoting the product." – LusiTiny*

> *"Even yesterday I received an e-mail from a beekeeper, saying that he was interested in being a partner of our project." – BeeRural*

As referred by BeeRural and LusiTiny creators, some advantages appear after the online campaign has ended. It is important to highlight that long-term benefits are sometimes created because of the online exposure, even after the end of the campaign.

**Test the market**

Crowdfunding campaigns allow for a low risk or even riskless market test. The feedback is, at this stage, a powerful tool to enhance the project and can be used to minimize long term risk. A positive feedback is considered an approval by potential customers and the number of supporters and amount of money raised are often seen as a quantification of the commercial value of the project.

> *"It was a market test, we wanted to understand the receptiveness and the acceptance of the general population"* - LusiTiny

> *"It was a matter of promotion and communication of the project itself; understanding the acceptance and the curiosity it arouses*…" - LusiTiny

> *"It was very important to receive the feedback from the people. We got a lot of appreciation messages for our project, its image, and it is very significant for us to have that kind of validation." – BeeRural*

> *"We even thought that if our campaign did not raise the money we needed, that we would send out a survey asking people why they did not support it: to know whether it was due to lack of money, whether there really was no interest or whether the project was not promoted correctly. Even when crowdfunding campaigns do not succeed, people need to be questioned." – Pictomed*

Through the analysis of these quotes, we realize how project owners can also use crowdfunding in order to obtain feedback for their projects, test their ideas and their market acceptance. It allows them to "*understand the receptiveness and the acceptance"* of potential consumers, so it works as a market test.

Leite (2012) considers that the use of crowdfunding allows for people to test the market by giving visibility to ideas before actually making an investment; it promotes the image of the brand and the creation of a fan base before its formal constitution, with low agency costs and without any costs of market research. We agree with this idea on the basis of the statements collected.

**Respond to contests**

Several interviewees mentioned that they were challenged by entrepreneurship contests to use crowdfunding as a financing method. In these contests there were business partnerships between the company or institution responsible for the competition and the crowdfunding platforms, allowing the contesters to use their tools.

> *"We turned to crowdfunding through a competition, "Aveiro Empreendedor". The City Hall of Aveiro created a contest that would involve a crowdfunding campaign through MassiveMov. Since we needed funding… so it happened." – Liquen Boards*

> *"We used Bet24's channel, which promoted the finalist projects; that was great, because it gave our project some credibility. On the other hand, Bet24 awarded a prize to all finalists who wanted to create a crowdfunding campaign; even when the goal amount was not achieved, they could still keep the raised sum, - Pictomed*

*"At the time, we were applying to "Aveiro Empreendedor" and our goal was to develop our business idea. The product was not on sale yet and we were precisely trying to launch it, doing a pre-sale. We were developing the business plan and the business idea while applying to "Aveiro Empreendedor". The better developed finalist projects would have the possibility of creating a crowdfunding campaign." - BeeSweet*

Some competitions use crowdfunding as part of the evaluation, so contestants are encouraged to do their best improving and promoting their campaign. When crowdfunding is part of a competition, project owners are highly motivated to use it. Thus, besides the need to collect money, to advertise the project and to test the market, the desire to win these competitions is also a strong motivation to use crowdfunding.

**The meaning of success**

Regarding success, almost everyone has a personal definition of its meaning. The same happens within the crowdfunding campaigns: every project initiator has his/her own definition of success, depending on their expectations. Sometimes it is evaluated gradually within a certain time frame, and sometimes at a specific point in time. The assessment can be influenced by one or by many factors and it can vary, depending on the feedback collected after the lifetime of the campaign.

*"In my particular case, I would say* [success means] *to achieve the pleaded monetary goal. But perhaps I could also mention a second aspect – the exposure/impact we had on social media, within our target community. The monetary goal was not achieved. We fell short of meeting our expectation. But regarding exposure, we had a very positive feedback." – Liquen Boards*

*"It's a sequence of consequences. In our case, success has to do with product innovation, with the passion we have for our company and the business idea, and with the capacity we have to be resilient and perseverant, and to not give up – not in the first try, not in the second try… and so on!" – BeeSweet*

**Hindrances to crowdsourcing**

During the interview process, our interviewees mentioned other issues, thus revealing their perceptions on crowdfunding. In particular, they mentioned the differences between the use of this tool in Portugal and in other countries they know about, as well as their unexpected impacts. It is important to point out that most of them consider that there is a lack of awareness about crowdfunding in Portugal, which is referred to as an obstacle. This financing tool depends on the general population, which means that if people do not know what crowdfunding is and how it works, it will not work properly and its benefits will not materialize. Project owners reminded that the requested amount should be small in order for the campaign could be successful.

*"In Portugal [crowdfunding] is not at the same level as in other countries, which includes the support base… Even when we think that the campaign is good, people do not contribute…" – Quase um Doutoramento*

*"Crowdfunding platforms in Portugal are not well spread. The community is not informed about what it is and how it works. There is a lot of fear to invest. (…) And what we felt was that we had to explain what crowdfunding was, how it worked and what the advantage was of supporting the campaigns or projects on the platform. (…) Unfortunately, in Portugal the amounts requested have to be very small in order to achieve monetary success." – Liquen Boards*

*"In Portugal, crowdfunding is still not very well developed. It is not a tool often used by start-ups or projects, precisely due to the fact that there is not much success and when there is, the amounts are quite small." – Pictomed*

Managing a crowdfunding campaign is an interactive process that requires full-time dedication, which is sometimes impossible, since most project creators have other occupations. Firstly, it is necessary to prepare the project presentation according to the platform requirements; after its approval, and while the campaign is online, the project initiator needs to manage the comments, respond to people's questions and promote the campaign. Having the necessary time to complete these tasks may be a problem. Thus we believe time constrains to be another relevant obstacle.

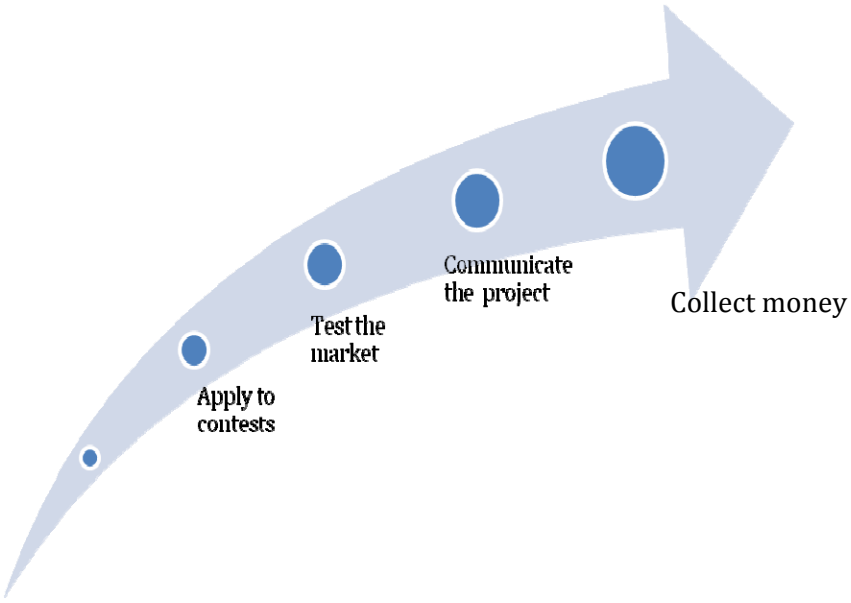
*"The crowdfunding campaign happened while I was in an international conference in China for seven days. A crowdfunding campaign needs to be advertised, has to be promoted within the social media. And in that period we really could not do it. We did not have the chance. We were focused on the fair, which was extremely important to us. There were many things happening at the same time…" – BeeSweet*

As previously mentioned, the projects subject to a crowdfunding campaign can vary; for instance, they can be scientific or artistic projects. However, the projects from social entrepreneurship seem to be easier to communicate and to be more likely to reach the proposed goals.

*"In Portugal [crowdfunding] works mainly for social entrepreneurship projects, that is, projects with a strong social impact, where sometimes rewards are not even material, but mainly acknowledgements… this kind of projects usually touch people's feelings!"– BeeSweet*

From the above we can conclude that, even though monetary goals are the most relevant ones, there are other measures to infer about the success of such projects which include the communication of the project, the market test of its underlying ideas, the reasons that drive people to use crowdfunding seems to be about collecting the money, plus communicating the project, testing the market and also, in some situations, apply for existent contests (see Figure 3).

**Fig. 3. The main factors for assessing a crowdfunding campaign**




This does not mean that all components need to be together so that the campaign can occur and be successful; it means that people use crowdfunding as a means to obtain (sometimes all of) these results. For example, the interviewee from LusiTiny project states that their main objective was communication, since they can rely on other financing sources.

> *"Most of all, [we needed] the promotion and not so much the financing. We could manage financing, given that we have some partners. It was a question of promoting public awareness of the project";* LusiTiny states, *"In our situation, for example, one [goal] was not achieved, while the other was. We did not increase our sales significantly, but we created awareness, which is extremely positive."*

## 5. Discussion and conclusions

The emergence of crowdfunding allows for several business ideas to be transformed into real projects without financing being an obstacle. Regarding this matter, after the completion of the crowdfunding campaign there is a need to evaluate it. The first point to analyze is the amount collected; according to the attainment or nonattainment of the established monetary goal, it is described as successful or unsuccessful.

However, according to the interviews conducted, despite the monetary goal being mandatory for the platforms, we conclude that there are, at least, three other dimensions that should be considered and integrated when defining a project as being successful or unsuccessful:

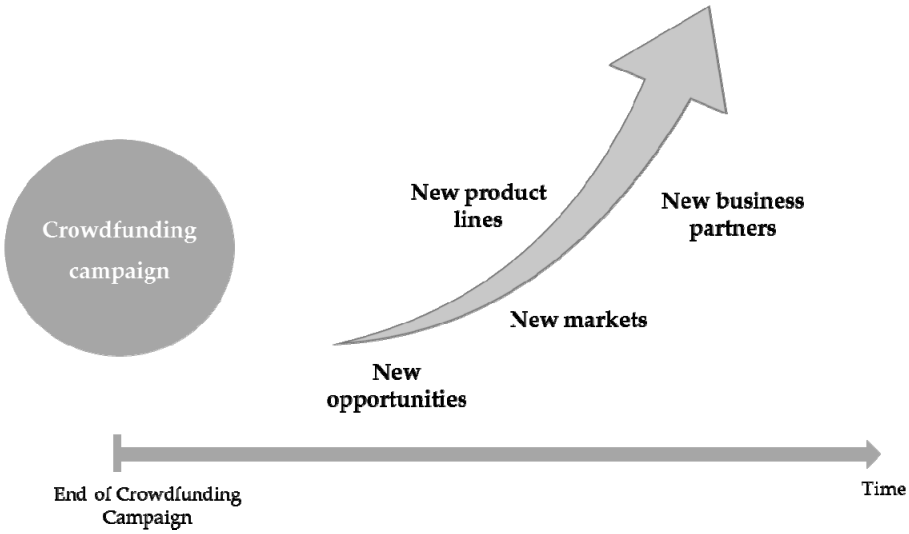
**Communication/Advertisement:** the business idea or product is promoted in the platform as a new campaign. Not only the platform publishes it but the project owner, as well as their friends, colleagues and others, who spread the word so that it reaches as many contributors as possible, also publicizes it. As in viral marketing, the propagation of the message is fostered because it is communicated within a network of contacts that trust the sender and open it; and also because it tends to be spread on the Internet, which makes its dissemination free and easy. Because of this process, the project is given a lot of promotion that would not happen otherwise.

**Market test**: it offers creators the opportunity to put their idea or product directly in contact with potential buyers/investors/interested people. It is possible to assess whether a sample of a product/service/idea will sell and even improve it before it is produced in a larger scale. Therefore, we are able to conclude that crowdfunding is not exclusively about collecting money: the business idea can grow even without the monetary goal being achieved; the benefits of public exposure in crowdfunding platforms allow project creators to upgrade their potential or/and real business. Even when the monetary goal isn't achieved, these other factors could have a positive impact in the project and lead to success.

**Respond to contests: c**urrently there are more and more initiatives, shaped as contests. Project initiators are invited and stimulated to participate in these contests. There are cases in which these contests are launched to establish initial partnerships between ideas' creators and investors, who are interested in getting to know about ideas, in many cases associated to new business models. In some cases, just the information and the exposure to other people's creativity or new ideas is enough to promote a contest. Contests are also means to channel public funding to projects that need to be sealed as valid and promising. As these contests can normally count with the participation of an expert jury, applicants submit their projects to their assessment. This way, besides an eventual prize, they can also benefit from knowledgeable feedback.

Overall, the benefits of this tool are suggested to have a long-term impact on the project. In a certain way, it extends the benefits of participating in a crowdfunding campaign to the lifetime of the campaign itself. The evaluation of the success of a given crowdfunding campaign is not a process that ends with the end of that campaign; the crowdfunding dynamics require several evaluations, according to the opportunities that appear. We can say then that it is possible to infer about the impact of crowdfunding in a business development, even after the end of the online campaign (see Figure 4).

**Fig. 4. Crowdfunding campaign long-term benefits**




It was also possible to conclude that there are, as it would be expected, some aspects that could limit the use of crowdfunding. Project owner feel that there is a lack of awareness about crowdfunding in Portugal, which hinders the interaction between creators and donators. In this respect, the use of this tool in contests and challenges is beneficial, since it has the potential to improve crowdfunding awareness and use in the general population. Project owners also expressed their opinions concerning the availability of the donators to contribute. In Portugal, people are still more likely to donate when they are somehow related to the project initiator. Therefore a project might benefit more from a large social network than from an exceptionally developed campaign.

During our empirical work, we were also able to observe that the most popular method of crowdfunding in Portugal is the one in which, in exchange for monetary contribution to the project, contributors receive a reward, which may be for example an article of the final product, an acknowledgement, or a discount. Besides the evident connection between creators and final user/investors, it is important to point out other advantages associated with this type of interaction: the product is tested even before being produced on a large scale, being possible to obtain feedback and make improvements at an early stage; and when presenting the idea/product for raising monetary contributions, the product is disclosed and advertised, thus there is a chance of increasing its visibility. Associated with every campaign, there are objectives defined by each project owner, which may simply be achieving a monetary goal or also taking advantage of other inherent benefits, such as the three types we identified: communicate the product /service/idea, test the market and apply to existent contests. These factors allow us to respond our initial research question, which had to do with the identification of the factors, which contribute, to the success of the phenomenon crowdfunding from the point of view of the project owner.

In this paper, limitations regard mainly the following points: firstly, only the Portuguese cases are analyzed. Crowdfunding is a global phenomenon, but it is still underdeveloped in Portugal when compared to other countries, such as the United States, for instance. This fact hindered the selection of a larger sample. Secondly, the themes of crowdfunding projects are so heterogeneous that the sample used is too limited to cover and represent the majority of them. This point could be tackled by enlarging the empirical study to other realities, namely in countries where this phenomenon is already at place for longer time; where the process is more well known among individuals and therefore more prone to be used at other stances/projects.

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