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Research Article

A transdisciplinary policy to maximize regional supply-links economic value through credit allocation

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Abstract
Many financial institutions address regional economic development as a corporate driver, but they usually focus on individual application credit risk assessment without a long-term policy to impact regional economic development systemically (considering all stakeholders). One way to promote economic development is by increasing value creation in current supply chain links and participating in more links (outperforming competition). Financial institutions are essential in this endeavor. By using a transdisciplinary approach (method) that involves a number of engineering (engineering economics, mathematical programming) and non-engineering disciplines (finance, accounting, banking, policy making) that consider the complete set of stakeholders (actors such as credit applicants, financial institutions, society at large, governments, among others), the contribution of this work is a framework to design a transdisciplinary credit allocation policy that financial institutions could rely on to have a targeted aim significant impact in the strategic economic transformation of focused regions. The proposed framework shows its significant systemic regional economic effects compared to traditional credit allocation methods. The article provides a numerical illustration for practitioner benefit and highlights the framework advantages.

Keywords: credit allocation, multiobjective optimization, regional sustainable development, supply chain/link value added, transdisciplinary approach.

1. Introduction

Corporate philosophies of multiple financial institutions (including developing banking) address regional economic development as a solid corporate drive. For instance, the Bank for International Settlements (BIS), the oldest international financial institution to date (Bank for International Settlements, 2022a), has played different critical roles in the global economy (serving central banks for monetary and financial stability). The fourth bullet point of its mission states to "foster a culture of diversity, inclusion, sustainability, and social responsibility" (Bank for International Settlements, 2022b). Many Microfinancing Institutions (MFIs) started with socially oriented missions; however, many have later transformed themselves into profit-seeking organizations (Augustine, 2012).

Robust Financial institutions (FIs) could pave the way for strengthening the international financial flow (Kawai, 2010) for wealth creation and social development. Local FIs (LFIs) differ from traditional banks, especially when they are registered as non-profit organization mutual funds or cooperative credit societies (savers contribute to the financial capital of the institution through contributions, maintaining equitable rights over the performance of the loans). With changing global environment and uncertain situations like the economic recession of 2008, FIs turned towards Financial Sustainability (FS), widening their scope of financial services to function with reduced government and donor funding. The situation resulted in sustainable FIs who charged interest rates covering the total cost of their financial services and providing financial instruments like savings services per local needs (Adhikary & Papachristou, 2014). Nevertheless, there has been increasing concern that focusing on FS may hurt the primary objective of societal outreach and sustainability. Therefore, in the current context, productivity improvements in financial performance and social outreach benefits can be attributed to the financial sector through financing aid (Hermes et al., 2011). Also, in developing banking, the government and concerned authorities need to bring innovative models and business practices to ensure the sectoral growth of LFIs, which would help them serve their key goal of providing financial benefit to the opportunity-inequitable section of society.

Academic literature identifies the conflict between these institutions' overall impact and FS (Augsburg & Fouillet, 2010). Development banking is also an example of this Conflicted Dual Objective (CDO). The emphasis on FS of MFIs is of concern as it could negatively impact their key goal of achieving societal outreach (Quayes,

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2012). The issue is clear, but how to solve it remains unclear (Woller, 2007). FS is key to maximizing regional economic value, specifically fostering Sustainable Supply Chain Design (SSCD) (Sabogal-De La Pava et al., 2021).

Sustainable Development (SD) and Credit Allocation (CA) by Financial Institutions (FIs) are highly related (Liu et al., 2010). Responsible banking practices yield endogenous economic growth; thus, banks' loans are an accelerator for the economies (Sipahutar, 2016). The leading objective of CA is to foster wealth creation and social impact (Mia & Chandran, 2015). In this sense, contracts are instrumental in achieving this purpose. These contracts contain embedded multicriteria elements to achieve coordinated/integrated institutional use of capital (Levine & Zervos, 1998). In some economies, funding sources are taken from financial markets, while banks are critical to encounter financial needs in many countries. In such banked economies, FIs enforce contracts (Ergungor, 2004) to handle CDO. FIs should have a sustainable financial product design to maximize social, environmental, and economic outreach. Hence, the diversity of FIs (cooperative, savings, and private banks, among others) target to create wealth for local economies (Burghof et al., 2021) along with SSCD.

To approach complex challenges (CDO is undoubtedly one), Ertas (2010) suggests that "neither mono-disciplinarity nor inter- or multi-disciplinarity provides an environment that promotes collaboration… and produces creative and innovative solutions to large-scale, complex problems", suggesting a Transdisciplinarity approach. Wognum et al. (2018) recognize "the identification of engineering problems that require a transdisciplinary approach" as a challenge. In this spirit, the Transdisciplinary approach could be the key to solving MFIs conflicting objectives (financial return, social, economic, and environmental impact) (García-Pérez et al., 2018; Sabogal-De La Pava et al., 2021; Rikakis et al., 2019) by including engineering and non-engineering disciplines, considering the integration/connection between stakeholders (financial institutions, entrepreneurs, workers, and suppliers, among others) to create SSCD with a higher opportunity to pass the test of time.

Global supply chains involve several links that cross international borders and several domestic regions. One way to promote regional economic development is by identifying the local supply chain links with value increase potential. In addition, identifying external supply chain links with regional assimilation potential (by new local links with higher performance) is a second way to do so. In this fashion, financial institution credit allocation is critical.

Mentzer et al. (2001) define a supply chain as "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and information from a source to a customer." In a commercial relationship, there is peer financing, and this financing reduces the risks of bank financing and liquidity due to trade credit or early payment between supply chain members (Juhász & Felföldi-Szúcs, 2022). According to Juhász & Felföldi-Szúcs (2022), the credit risk of financing a cooperative member of the supply chain (SC) "is more moderate than the financing of an individual firm with the same operational risk because cooperative SC members may counterbalance liquidity shocks affecting their partner company." Supply chain finance is an approach that aims to optimize financial flows at the inter-company level (Hofmann, 2005; Wuttke et al., 2013). This approach, in its application, reduces the cost of debt and allows 'weak' actors in the supply chain to access credit (Randall & Farris, 2009). Jin et al. (2019) mention that "access to bank finance is vital when both firms are capital-constrained." This financial capital allocation approach has effects on the chain. Zhai et al. (2020) investigated that bank loans significantly increase the performance of the supply chain when its members face capital constraints. Raghavan & Mishra (2011) proved that if one member has low cash reserves, the collective judgment of the lender outperforms individual funding for the debtor and the bank (Juhász & Felföldi-Szúcs, 2022).

Supply chain orientation is towards service, quality, and cost/time efficiencies. This approach has led to adverse side effects such as climate change. According to Baid & Jayaraman (2022), ESG investments were $40 trillion US dollars in 2021, with an expected increase of 30% by 2025. Socially motivated investors consider aligning social impact criteria to maximize returns. (Baid & Jayaraman, 2022). Baid & Jayaraman (2022) focused on "regulatory focus on organizations to address the adverse impacts their supply chains have on environmental, social and governances (ESG, first introduced in 2006 in a UN report) related issues," pointing out the relevance of measuring social impact within the supply chain. Baid & Jayaraman (2022) introduced this framework in the context of supply chain financing that "discusses the integration of cash flow with both product and information flows along the supply chain." Sustainable finance considers capital allocation criteria focus on economic returns; and environmental and societal goals of organizations (Ferreira et al., 2016; Tseng et al., 2019).

Engineering and management science provides tools, like multiobjective mathematical programming, that can handle several objectives in conflict from a theoretical stand (Colapinto et al., 2015). Industrial engineering, management, economics, and logistics, among other fields, have applied multiobjective optimization to analyze trade-offs between conflicting objectives (Sabogal-De La Pava et al., 2021; Sawaragi et al., 1985). The formulations of linear and non-linear goal programming (GP), lexicographical GP, weighted GP, polynomial GP, and fuzzy GP are widely used (Asllani, 2018; Colapinto et al., 2015; Hillier & Lieberman, 1990; Marler & Arora,

2004) in engineering (Sioshansi & Conejo, 2017). Financial decision-makers aim to balance the conflict of minimizing risk and maximizing the return on investment in portfolio management (Liu et al., 2010; Martinsuo, 2013). Academic literature on applying these methods in transdisciplinary applications focusing on SSCD and economic spillovers to stakeholders is scant.

The approach in this paper focuses on the dual for-profit and non-profit purposes of microfinance institutions, such as credit unions. Academic literature on the use of optimization techniques in investment planning in credit unions is scant. However, the central problem is to define the proper priorities in the allocation process (Sharma et al., 2002). Banks, as social accountants, screen credit submissions regarding moral and technical aspects for assessing creditworthiness (Catturani et al., 2016; Kiviat, 2019; Stiglitz & Weiss, 1988). Credit allocation is composed of two stages (Kumar et al., 2021). The first stage computes the probability of default to predict if the beneficiary is a non-defaulter, considering indebtedness and credit history. A second stage assesses the financial returns of the credit submission. Sharma et al. (2007) propose a mathematical programming model for credit union portfolio management. Mia & Chandran (2015) highlight the relationship between FIs, financial sustainability, and social outreach. In this context, a transdisciplinary approach is critical.

The contribution of this work provides a framework (a method that includes a ready-to-use tool for decision-making support) to design a Transdisciplinary Credit Allocation Policy (TCAP) that a Host Credit Institution (HCI) could use to target the strategic economic transformation of focused regions. This paper is a revised and extended version of Trigos & Aldana (2022).

This paper is organized as follows: Section 2 sets our methodology as a transdisciplinary capital allocation policy to maximize Regional Supply-Links Economic Value (RSLEV); Section 3 illustrates the method through an industrial size case. Section 4 discusses conclusions and further research.

2. Methodology

Table 1 shows the TCAP methodology. The policy's user is the HCI. Examples of HCI that can benefit from TCAP are Development banking, Microcredit institutions, and National banks, among others. TCAP's three steps are:

1) Identifying the region to be the focus of the endeavor, the decision-making time horizon, the supply chains, and their corresponding (current and potential) links within the region to be focused on, along with the industries participating. In addition, it identifies a number of Key-Value Objectives (KVO) to impact per industry, along with their weights. Some examples of these KVOs could be the impact of credit allocation on labor (which could be further divided into Minorities, gender, etc.), regional suppliers, infrastructure, environment, and entrepreneurship, among others. In this way, stakeholders' impacts are identified and considered. Since the lifetime of each CA varies, the use of Net Present Value or Annual Equivalent methods from Engineering economics is in order (Park & Sharp-Bette, 1990). Strategic planning from the HCI sets periodical budgets and expected return from CA.
2) For every industry at each decision-making period, a number of credit submissions are received at the HCI. Each submission must be related to:

   a. enhance value creation at a regional current supply links (identified in Step 1), or

   b. assimilate external supply chain links by local operations (outperforming current external ones).

Submission pre-screening discards the ones beyond the industry and institution risk levels. Bessis (2015) highlights the importance of satisfying banking regulations. Once the HCI has identified a set of financially solid applications, it must analyze each application's cash flow to determine the impact of the credit on each KVO.

The multiobjective mathematical programming model (3) through (6) is used to select the CA that maximizes a weighted average of KVO and satisfies the HCI budget and minimum CA expected return for the chosen industry in the period under analysis. In this way, the HCI achieves a transdisciplinary approach to the matter. For each credit application selected by (3)-(6), HCI and the applicant must sign credit contracts to meet the obligations stated by the KVOs ($O_{i,j,t,k}$) in section 2.3 of Table 1.

Figure 1 shows a graphical representation of the policy, the base of the figure shows the potential of TCAP to obtain additional funding from domestic and or international, as well as private or governmental sources.

Table 1. Transdisciplinary Credit Allocation Policy.

Steps	Description

1. Policy setup and budgeting	1.1 Select a specific region. 1.2 Define the time horizon of T decision-making periods (with $1 \leq t \leq T$). 1.3 Identify the supply chains participating in the region along with current and potential links. 1.4 Select m regional industries (with $1 \leq i \leq m$) with participation in step 1.3 to impact. 1.5 For every industry i identify n_i KVOs (with $1 \leq j \leq n_i$) aimed to impact. All KVOs must be measured in the same currency. 1.6 Define the HCI's budgets ($B_{i,t}$), expected CA returns ($R_{i,t}$) of credit allocation selections, and the impact policy weights ($w_{i,j,t}$) per industry i, sustainable key value objectives j, and period t. The weights must satisfy every industry i and period t $\sum_{j=1}^{n_i} w_{i,j,t} = 1 \quad (1)$ $w_{i,j,t} \geq 0 \; \forall j \quad (2)$ To complete this step, the Transdisciplinary Team requires deep knowledge of local and international regulations, markets, industries, economic sectors, and politics.
2. Periodical credit allocation decision making	2.1 For every industry i at period t, several credit submissions aiming to enhance value at current regional supply chain links or to assimilate external ones are received to be analyzed by the HCI 2.2 Pre-screen every credit submission received at the beginning of period t related to the regional sustainable supply-links development of industry i, using general (include institutional, national, and international standards as needed) accepted banking principles (local and international) resulting in $C_{i,t}$ financially solid credits (with $1 \leq k \leq C_{i,t}$). This pre-screening step requires the Transdisciplinary Team to have deep knowledge and understanding of local and international banking regulations, industrial standards, credit risk assessment methodologies, and ethical compliance factors 2.3 For every credit submission k identify the expected regional impacts to RSLEV for every KVO ($O_{i,j,t,k}$), its return for the HCI ($r_{i,t,k}$), and the funds requested ($Fo_{i,t,k}$). 2.4 Mathematical optimization The following credit allocation multiobjective binary optimization model will determine the CA optimal set (the set of $x_{i,t,k} = 1$) of accepted credits for RSLEV added to the industry i at periods t.
2. Periodical credit allocation decision making	$Max \sum_{j=1}^{n_i} \sum_{k=1}^{C_{i,t}} w_{i,j,t}\, O_{i,j,t,k}\, x_{i,t,k} \quad (3)$ Subject to $\sum_{k=1}^{C_{i,t}} Fo_{i,t,k}\, x_{i,t,k} \leq B_{i,t} \quad (4)$ $\frac{\sum_{k=1}^{C_{i,t}} r_{i,t,k}\, Fo_{i,t,k}\, x_{i,t,k}}{\sum_{k=1}^{C_{i,t}} r_{i,t,k}\, x_{i,t,k}} \geq R_{i,t} \quad (5)$ $x_{i,t,k} = 0$ or $1 \; \forall i,t,k \quad (6)$ The HCI's executive credit committee should review the CA of accepted submissions proposed by the latter model to check for qualitative considerations not included in the model to make a final decision on the credits to be accepted in this period (t) to create RSLEV.

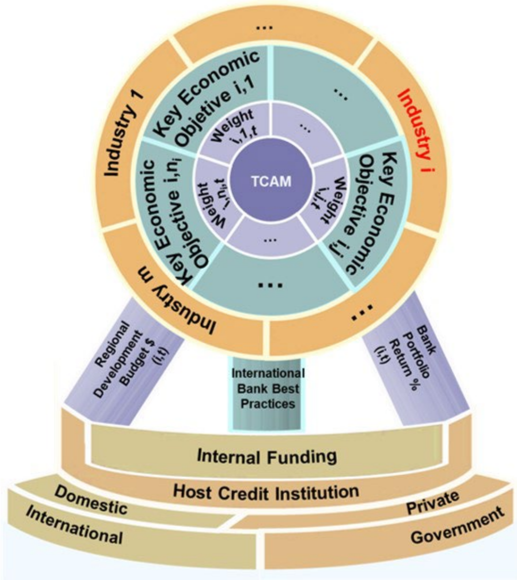

Figure 1. The Model for the Transdisciplinary Credit Allocation Policy (TCAP).

3. A numerical illustration

This section aims to illustrate, for the benefit of practitioners, the mechanics of TCAP, shown in Table 1, on an industrial-size numerical instance.

A national financial institution (HCI) is planning on having a substantial annual influence on the RSLEV development of the fourteen states of the nation (Step 1.1) for a planning horizon of five ($T = 5$, where $1 \leq t \leq T$) years (Step 1.2). Five global supply chains have links within the region, and some potential links assimilations have been proposed (Step 1.3). The HCI has identified three ($m = 3$ where $1 \leq i \leq m$) major economic industries related to Step 1.3 to influence (Step 1.4): agriculture ($i = 1$), electronics ($i = 2$), software development ($i = 3$).

For simplification, the TCAP will be illustrated for industry 1 (agriculture), where five ($n_1 = 5$ where $1 \leq j \leq n_1$) KVOs were identified: entrepreneurship net profit, labor, regional suppliers' profit, water use efficiencies (savings), and crop yield growth (revenue measured by the commodity's market value) (Step 1.5). All KVOs are measured in local currency.

Regarding crop yield growth, one must consider food safety and environmental impact. For instance, avocado is a tropical tree with high water consumption, and this fact is critical for regions at risk of desertification. However, avocados' growth results in farm-yield higher revenue because of the commodity market value. In comparison, one should balance crops that consume less water but need to produce close to the same potential yields (Van Ittersum et al., 2013). As Mueller et al. (2012) pinpoint, "meeting the food security and sustainability challenges of coming decades is possible but will require considerable changes in nutrient and water management." This way, TCAP could be used to be compatible with sustainability endeavors.

HCI has defined an annual budget of \$2,000,000 to be allocated for the planning horizon ($B_{1,t} = \$2{,}000{,}000$, where $1 \leq t \leq T$). The financial institution expects a minimum annual credit allocation return for this industry given by $\{R_{1,t}\} = (40\%, 41\%, 42\%, 42\%, 43\%)$ (Step 1.6). Table 2 summarizes the data for TCAP in agriculture Step 1. At the beginning of the first year, the HCI received 150 credit submissions related to the impact of current or potential supply chain links in agriculture. The institutional financial screening found that only forty ($C_{1,1} = 40$) were financially solid (Step 2.1). The requested capital ($Fo_{1,1,k}$), the return for the financial institution, *i.e.*, bank interest ($r_{1,1,k}$), and the impact on every KVO ($O_{1,j,1,k}$) defined for this industry are shown in Table 3 for every credit submission ($1 \leq k \leq C_{1,1} = 40$). Notice that the bank interest ($r_{1,1,k}$), refers to the interest paid (in percentage) by the applicant to the bank. This loan bank interest is highly related to the applicant's creditworthiness or the default risk for the financier (Horcher, 2005). This completes Step 2.2. The credit allocation multiobjective binary optimization model (3) through (6) can be written and solved with this information.

The model was implemented and solved in GAMS using a MacBook Air under macOS Monterrey Version 12.5.

GAMS solved the model in (3) through (6) for t=1 in negligible computer time. The subset of credit applications (with $x_{1,1,k} = 1$) selected by the model are given by the following set $\{k \middle| x_{1,1,k} = 1$: 7, 9, 11, 14, 15, 16, 17, 19, 23, 26, 28, 29, 31, 32, 33, 34, 35, 37, 40$\}$ making a CA return of 41.60% using \$1,993,803 of the HCI budget. The weighted average of KVOs for this industry at period 1 (3) is \$147,215.649. Meanwhile the individual impacts are net profit $942,183; labor $38,058; domestic supplier $103,588; water use savings $29,022; crop yield growth revenue of $76,813.

With the results from the model, the next step is to present them to the HCI committee to make the final decisions on the CA set.

HCI maximizes the RSLEV by executing TCAP for periods 2 through 5 (as time goes by) in all three industries.

Table 2. Agriculture, industry policy setup, and budgeting data (TCAP Step 1).

	Planning Periods (t)				
	1	2	3	4	5
$B_{1,t}$ ($)	2,000,000	1,900,000	1,900,000	1,700,000	1,600,000
$R_{1,t}$ (%)	40	41	42	42	43
Key Value Objective (j)	**Impact Policy Weights ($w_{1,j,t}$)**				
Net profit	10	10	10	10	20
Labor	15	15	20	25	25
Domestic supplier	15	15	20	25	25
Water use savings	30	30	25	20	15
Crop yield growth revenue	30	30	25	20	15
Sum	100	100	100	100	100

Table 3. Set of 40 pre-screened credit applications considering five regional supply chain value objectives for industry i at time t for the numerical example.

Pre-screened submissions (k)	Net profit ($)	Labor ($)	Domestic supplier ($)	Water use savings ($)	Crop yield growth revenue ($)	Bank interest (%)	Requested capital ($)	Pre-screened submissions (k)	Net profit ($)	Labor ($)	Domestic supplier ($)	Water use savings ($)	Crop yield growth revenue ($)	Bank interest (%)	Requested capital ($)
1	36,795	2,769	5,214	1,833	5,558	19	143,838	21	10,698	1,200	5,231	1,458	3,076	12	139,067
2	14,153	1,273	5,830	1,119	686	59	132,476	22	14,079	1,519	5,124	1,061	1,614	13	128,620
3	43,782	1,297	5,945	1,964	2,269	66	140,933	23	37,739	1,825	5,333	1,573	851	47	89,518
4	45,291	2,060	5,444	1,114	1,585	54	142,644	24	31,180	1,895	5,545	1,347	1,192	28	104,654
5	36,785	2,833	5,965	1,532	853	44	115,756	25	10,101	2,089	5,284	1,384	158	69	97,171
6	27,250	2,229	5,954	1,651	2,766	20	142,458	26	58,679	2,415	5,868	1,927	8,004	25	120,491
7	40,098	2,439	5,348	1,632	4,159	35	80,678	27	17,677	2,143	5,230	1,362	808	49	139,914
8	46,074	2,724	5,348	1,005	2,449	70	133,408	28	15,581	2,959	5,220	1,787	641	60	92,069
9	69,751	2,613	5,674	1,666	3,408	70	107,744	29	56,423	1,753	5,111	1,420	1,120	70	93,106
10	44,229	1,066	5,003	1,005	2,394	51	144,777	30	16,635	2,529	5,085	1,128	753	59	102,393
11	63,957	1,348	5,419	1,727	6,980	35	146,830	31	33,540	1,205	5,392	1,040	2,859	44	80,410
12	37,069	2,290	5,024	1,514	2,030	63	141,575	32	64,081	2,427	5,980	1,294	1,213	65	81,384
13	11,806	1,656	5,130	1,287	773	51	131,434	33	49,141	1,466	5,920	1,237	1,902	54	85,578
14	65,790	1,500	5,636	1,058	6,639	11	83,295	34	57,462	1,415	5,205	1,485	3,112	65	133,374
15	44,283	1,491	5,092	1,671	2,322	33	96,150	35	30,953	2,803	5,123	1,287	5,947	14	109,948
16	30,874	2,107	5,268	1,097	2,003	37	90,072	36	39,529	1,743	5,395	1,603	1,770	65	139,560
17	62,231	1,801	5,768	1,665	11,726	19	103,347	37	48,246	1,749	5,461	1,732	1,284	56	122,646
18	24,777	1,585	5,228	1,689	1,044	47	111,653	38	28,633	1,934	5,363	1,394	1,646	32	127,710
19	59,464	2,309	5,243	1,997	2,657	47	128,216	39	35,598	2,676	5,261	1,874	4,456	27	129,787
20	10,184	1,247	5,457	1,908	367	70	102,162	40	53,890	2,433	5,527	1,727	9,988	15	148,947

The current solution is based on the Maximization of the Weighted Sum of KVOs, then it will be called scenario (MWSKVOs). For comparison purposes, two more capital allocation scenarios are considered. Scenario maximizing net profits (MaxNetProfit) solves (2) through (6) with Impact Policy Weights $w_{1,Net\ ptofit,1}$=1 and zero for all the other KVO ($j's$) in the same period 1 and industry 1. This scenario seeks to maximize the economic spillover on credit applicants' wealth, subject to bank budgetary constraint. A third scenario (MaxBankReturn) aims to maximize the bank's return of the credit allocation, i.e., Maximize the left-hand side of (5) subject to (4) and (6). Notice that the bank return is defined now by a non-linear function. These two comparison scenario models were solved in negligible time by GAMS in the same MacBook Air under macOS Monterrey Version 12.5. Table 4 summarizes the three solutions. Even though the sum of regional spillovers and bank investment (sum of KVOs) are similar for MWSKVOs and MaxNetProfit scenarios, the latter makes a slightly higher bank return, making net profit a priority in favor of the companies benefited by the credit allocation.

The third scenario (MaxBankReturn) is of special consideration. Notice that the bank return is significantly higher (70% Versus 41.6% and 45.3%), but the bank investment is significantly lower ($436,420 versus $1,993,803 and $1,977,766) selecting only 4 out of 40 credits. A budget surplus of 1,563,580. These results make one question the true mission of banking. Scenario MWSKVOs involves significant work from HCI and applicants on defining all elements of TCAP. This work pays back on systematic, planned economic development of the region over the planning horizon. Scenario MaxNetProfit only cares about the sum of the company's net profit, creating maximum value for business owners. Scenario MaxBankReturn, only focuses on HCI return, therefore allocating credit to the projects with a higher bank interest (maximum risk) and resulting in a high budgetary surplus. Remember that all credits considered by the optimization model were pre-screened using the bank accepted risk criterion (TCAP step 2.2). Nevertheless, this scenario might require a stronger follow-up on creditors' operation. This study leaves the bank with the question of what to do with the budgetary surplus. One answer is to explore new banking venues.

Since this work aims to promote regional supply chain link value, the illustration provided in this section confirms that TCAP is an alternative to regular development banking practices such as MaxNetProfit and MaxBankReturn, among others.

Table 4. Comparison of results and impacts of different capital allocation models.

Scenarios	MWSKVOs		MaxNetProfit		MaxBankReturn
Optimization Model	Max (3) s.t. (4), (5). (6)				Max left-hand side of (5) s.t. (4), (6)
Bank Return		41.60%		45.30%	70%
Bank Investment		1,993,803		1,977,766	436,420
	Weights		Weights		
Net profit	10%	942,183	100%	956,140	182,432
Income salary	15%	38,048	0%	34,973	8,337
Domestic suppliers	15%	103,588	0%	98,769	21,590
Water savings	30%	29,022	0%	26,970	5,999
Crop Yield Growth	30%	76,813	0%	72,255	7,343
Sum of Spillovers		1,189,654		1,189,107	225,701
Weighted Sum of Spillovers		147,214		956,140	
Bank Profit		$ 829,422		$ 895,928	$ 305,494
Bank Budget Surplus		6,197		22,234	1,563,580
Submissions Selected	7, 9, 11, 14, 15, 16, 17, 19, 23, 26, 28, 29, 31, 32, 33, 34, 35, 37, 40		4, 7, 8, 9, 11, 14, 15, 17, 19, 23, 26, 29, 31, 32, 33, 34, 37, 40		8, 9, 20,29

4. Conclusions and further research

CA is a tool used by developing banks to enhance regional economic value. Academic literature highlights the difficulty of conciliating financial risk, societal outreach, and regional economic value. However, practical solutions are scant. CA framework kept through time by an HCI becomes policy. This paper contributes to regional sustainable development by providing a TCAP that an HCI can implement. The main emphasis of the proposed TCAP is to enhance regional economic value creation through the participating (or potential) supply-links within the region. A multiobjective binary optimization model is proposed to be used in each industry at every decision-making period through the planning horizon. The model aims to determine an optimal CA that maximizes RSLEV for all the defined stakeholders. In comparison, TCAP outperforms other regular CA practices by systematically targeting a specific economic region for the benefit of all defined stakeholders over a planning horizon. TCAP adoption involves a more profound knowledge of the HCI over the region in question and more work for credit applicants on preparing and filling out the credit application.

The policy could aid the HCI in obtaining additional funding from domestic/external, private/government institutions since it shows a systemic way to locate funding with the general objective of RSLEV creation. TCAP provides a basis for attracting investors who value sustainable impact and financial returns through sustainable-oriented lending.

Further research pends ahead. TCAP could be modified to be used beyond banking, for instance, for governmental (federal, state, or municipal) and-/or corporate purposes to establish budgeting and strategic planning policies. Besides, it is unclear, at this time, if the actor's (cooperating on the same supply link) credit risk is altered by the TCAP application. Furthermore, the introduction of stochastic processes and behavioral finance could be researched and included in TCAP.

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