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Quantifying Equity with Messrs. Markov, Lorenz and Gini: A Case Study of Dunster, British Columbia

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Quantifying Equity with Messrs. Markov, Lorenz and Gini: A Case Study of Dunster, British Columbia

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Abstract

Techniques for quantifying equity, which are discussed in the companion articles by the authors, "Quantifying Equity with Messrs. Markov, Lorenz and Gini: Retaining and distributing benefits in natural resource-dependent communities", and "Social network analysis, Markov Chains and input-output models: Combining tools to map and measure the circulation of currency in small economies", in this issue of JRCD, are applied by the primary author in a case study of Dunster, British Columbia, a small rural community heavily dependent on forestry revenue. The community has forestry tenure rights over a small area in the Robson Valley area of British Columbia, but as of 2011 had not yet begun logging. The application of the techniques highlight the challenges faced by small communities with limited industrial capacity in attempts to capture benefits from the extraction of natural resources. By establishing a "pre-logging" standard, the community can measure progress towards distributing the benefits of natural resource extraction equitably within the community.

Keywords: equity, community forest, management, resources, benefits

1.0 Background

1.1 Community-based Forestry in British Columbia

In Canada, ownership of forested land is held by the provincial governments ("The Crown"), and approximately 90% of the timber harvest Canada-wide is from public land (Sedjo, 2006). In forest-dependent B.C. particularly, over 95% of the land is "Crown land" (Niquidet, 2008). Although forest management in British Columbia has historically been the domain of the provincial government, through the use of volume-based tenures (B.C. MoFR, 2006), community-based forest management emerged in the late 1990s and early 2000s as an alternative approach. Pinkerton et al. (2008) and McCarthy (2006) each offer in-depth discussions of the political, economic and social factors that led to the establishment of a community-based forestry program in British Columbia.

A question facing community forests is whether to pursue the greatest sale price for their logs or provide greater access to logs locally, for value added enterprises such as local sawmills, log home builders, and other wood-related industries (Cathro, 2004). Focusing on obtaining the greatest sale value for raw logs allows the community forest to use this money towards community-based projects (Mulkey & Gunter, 2004). Alternatively, in recognizing that access to the natural resource is a benefit beyond the distribution of grants (Pinkerton et al., 2008), community forests could enhance the "multiplier effect" in creating direct and indirect economic benefits such as income and employment for local businesses. The harvesting of logs requires the purchase of fuel, which in turn requires an employee operating a store that sells the gas. These indirect contributions "multiply" the impact of the dollar spent within a community. If that gas is used to transport the raw logs to a distant community for milling, the opportunities for value-adding, such as local milling, are lost. That value-adding also has a multiplier effect, in terms of employment, products and services that are needed for the value-adding process.

1.2 How Community Forests in B.C. Obtain Revenue

There are three ways for a community forest in B.C. to obtain revenue, all of which involve logging. While community forests in B.C. do have rights to non-timber forest resources/non-timber products (NTFP) (Mulkey & Gunter, 2004), the fact that the tenured areas are Crown land limits the ability to exclude the public from accessing the land (Pinkerton et al., 2008). As a result, efforts to charge admission or other tolls are not legal. Marketing NTFPs such as berries and mushrooms has not been fully established in B.C. (Davis, 2011). With logging, the community forests may obtain revenue through (a) leasing cutblocks, or (b) hiring loggers to log (Cathro, 2004). Hypothetically, a community could let loggers choose the areas to log and charge them an effective "stumpage" rate over and above the provincial rate. This third approach differs from the first approach in that the first approach uses a fixed price to lease an area regardless of timber harvested, while the third approach charges for the timber harvested and scaled, similar to how the Provincial government charges community forests.

Timber buyers pay for the timber "as delivered," which means the seller pays transportation costs unless other arrangements have been made. Consequently the distance to the buyer is a factor in the transaction. Theoretically this should favor local mills that are closer to the seller.

1.3 Community Forests Face a Social Dilemma

In attempting to achieve an optimal balance of currency circulation and distribution of benefits, a community-based natural resource management institution faces a social dilemma (Andersson & Ostrom, 2008). The institution can attempt to maximize the collective outcome of the community, or it can attempt to obtain the maximum revenue possible for the sale of the resource (Cathro, 2004). If the institution attempts to maximize the collective outcome of the community, inevitably a situation will arise where the institution must accept a lower than market price for the resource.

An example is easily envisioned. Two local enterprises wish to purchase timber from a community forest. One enterprise mills the timber and works with additional local value added enterprises, while the other enterprise acts as a reseller for the logs to a large mill located outside of the community (no opportunities for local processing). The former enterprise offers more employment and more money

is spent within the local community, but also has to share costs in order to achieve this longer "chain" of businesses working together. In contrast, the reseller has less overhead and can pay more for the timber while still being profitable, at the expense of possible local value-added efforts. The hypothetical community forest has a "grants" program to disperse the revenues gained from the enterprises and to which community groups can apply for funding. The community groups may include local libraries, hospitals, wilderness preservationists, and other social-responsibility organizations that face chronic funding shortfalls under roll-back neo-liberal government policies (Brenner & Theodore, 2002; Ilcan, 2009) - a specific albeit disingenuous *raison d'être* given by the government of British Columbia for the creation and continued development of community forestry in British Columbia: "(P)rovide long-term opportunities for achieving a range of community objectives, values and priorities" (B.C. MoFLNRO 2001, n.d.). The more the community forest receives in revenue, the more community groups that can get funded or receive larger grants. Absent quantifiable transaction costs to the contrary, the community forest institution would be behaving "rationally" in accepting the higher revenue offered by the enterprise that also circulates less money locally.

This conflict was identified early in the development of the Community Forest program. In the *Community Forest Guidebook: Tools and Techniques for Communities in British Columbia*, Cathro writes:

> Most community forests are "market loggers," which means that they only generate revenue from the sale of logs and not from processing them. This is typical of some other smaller provincial licences, such as woodlot licences and independent logging contractors who work for BC Timber Sales.
>
> This situation underscores the importance of maximizing the revenue from log sales. It also highlights the tensions between keeping the logs local (to employ local mill workers) and getting the best price for logs (by selling them outside of the community for more money) (Cathro, 2004, p. 61).

1.4 Background of Case Study Community: Dunster, B.C.

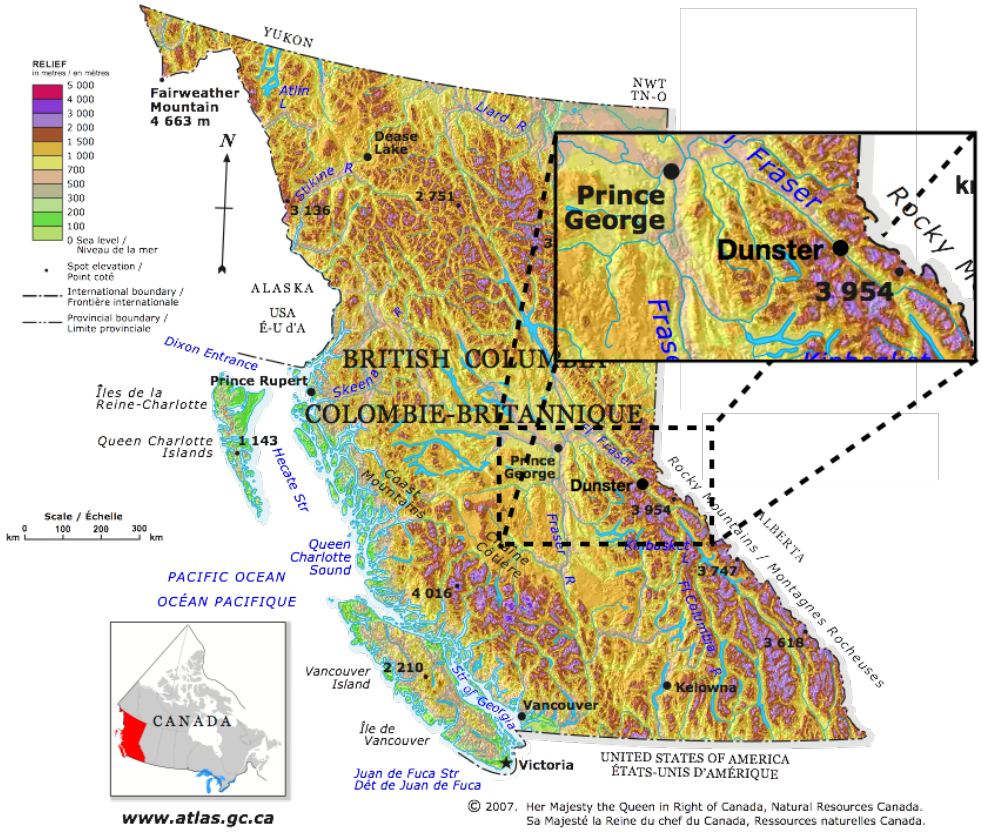
The Robson Valley area of eastern-central British Columbia is formed by two mountain chains coming together, the Cariboo Mountains from the southwest and the Canadian Rocky Mountains from the northeast. These two mountain ranges frame a narrow corridor running approximately 300 kilometers between Prince George to the west and Valemount to the east. The headwaters of the Fraser River form at the eastern edge of the Robson Valley, and the river flows through the Robson Valley northwest to Prince George before turning south through interior B.C.

One incorporated municipality and several small unincorporated communities currently exist in the Robson Valley, while several others have periodically been occupied and then abandoned in the last 100 years (Wheeler, 1979, p. 1-18). Just southeast of the center of Robson Valley is a small, unincorporated area called Dunster (see Figure 1.4.1). The community has a community forest agreement with the provincial government of British Columbia. Government-funded, location-specific population and socioeconomic demographics for Dunster do not exist, to the best of the primary author's knowledge. The most recent survey of such identified by the primary author is called "A socio-economic profile of the Robson

Valley: A study prepared for the Fraser Headwater Alliance" (Stamm, 2004), which was done before the closing of the local mills.

An estimation of fewer than 180 people in the Dunster and surrounding areas has been offered to the primary author by Dunster residents, who frequently noted the large number of "dark homes." The community of Dunster is isolated from substantive populations in McBride, B.C. (35 kilometers to the northwest) and Valemount, B.C. (60 kilometers to the southeast), with mountains and the absence of roads preventing travel to the northeast and southwest. The nearest Walmarts are in Prince George, B.C. (243 kilometers away to the west), and in Hinton, Alberta (222 kilometers away to the east, across the Rockies). The entire population of the 300km long Robson Valley is approximately 2000 people (Statistics Canada, 2007).

Figure 1.4.1: Location of Dunster, British Columbia.



Source: Natural Resources Canada

Dunster had pursued a community forest agreement since 2002 (A. McLean, personal communication, 2011). After several years of lobbying, the Dunster Community Forest Society (DCFS) secured an invitation to apply from the Ministry of Forest and Range, and in December of 2009, DCFS was awarded a 25 year Community Forest Agreement. The land tenure consists of 20,000 hectares and a 15,000m^3 Annual Allowable Cut (AAC) (DCFS, 2007). The tenure is on both the northeastern and southwestern sides of Robson Valley, but it is not contiguous due to private property on both sides between the tenure areas and Highway 16. Much of the tenure is on the south side of the leading edge of the Caribou

Mountains, in the Raush River Valley. This area is accessible through a logging trail that is too steep for skidding logs, at the end of a 22 km Forest Service road.

As part of a Future Forest Ecosystem Science Council of British Columbia (FFESC) grant, DCFS participated in the surveying of the local community economy. Dunster as a location provides few direct jobs. With the closing of the Dunster Fine Arts School at the end of the 2009-2010 school year, multiple-person employment has centered on agriculture and small mills employing one or two persons, plus some individual logging and forestry efforts. A General Store provides employment for a few individuals as owners of the store. Carrier Lumber provides out-of-town employment for an unknown number of other individuals. At the time of the surveying, the Dunster Community Forest had not yet begun to log, providing a unique opportunity to establish a baseline of currency circulation within the community prior to the influx of new capital (the community forest did undertake logging operations in 2012 and 2013).

2.0 Methodology

2.1 Quantifying Equity

As introduced in the companion article by the authors, "Quantifying Equity with Messrs. Markov, Lorenz and Gini: Retaining and distributing benefits in natural resource-dependent communities," in this issue of JRCD, this paper uses a modified Gini Coefficient and social network analysis-based Markov Chains to quantify the width and depth of the distribution of benefits from natural resource extraction. See the companion article by the authors, "Social network analysis, Markov Chains and input-output models: combining tools to map and measure the circulation of currency in small economies," in this issue of JRCD, for a rigorous treatment of this methodology. Fundamentally, though, the methodology uses business expenses within a community to create a map of the community's economy, calculates the number of times a dollar circulates in that economy, and calculates the distribution of expenses from each business to other local businesses. The two calculations are combined to quantify the equity in the distribution of benefits, by measuring both the width and depth of the distribution of economic benefits from resource extraction.

2.2 Identification and Surveying of Businesses in Dunster

The primary author identified thirty businesses in Dunster, using sources such as bulletin boards and newspaper advertisements, and visual evidence such as signs. Word of mouth was not used, as many individuals had "businesses" that were not publicly identified as such. Individuals were not solicited for information about their expense habits. Identified businesses were contacted directly by the primary author when possible, and asked to participate in a survey about their expenses.

This survey was developed by the primary author with the cooperation of Archie McLean, the Chair of the DCFS in 2011. The survey requested the listing of expenses by percentage to businesses for the years 2007, the year before the community forest agreement was awarded, and 2010, the most recent tax year at the time of the survey. Examples of how to fill out the survey were provided in the survey.

The primary author preprinted surveys and enclosed them in a stamped envelope pre-addressed to the primary author's mailbox at his summer location in a nearby town. On July 14, 2011, the surveys were placed in a box on the counter at the Dunster General Store, a central location in Dunster that contained the mailboxes

for the community. The box remained on the counter until August 25, 2011, except on Saturday mornings, during which the primary author accompanied the box at a booth at the local farmer's market. During the survey period, 49 surveys were printed and distributed through the box or direct interviews. Of these, 13 surveys were returned, 12 of which were useable (the remaining was from a business outside of the Dunster area). Four of the surveys were returned by mail, six were filled out in person with the primary author, and two were sent by email after August 25, which were then manually entered into a paper survey. Two surveys were recovered in an incomplete form, and five surveys were recovered from the box at the Dunster General Store. Twenty seven surveys were unaccounted for.

Table 2.2.1. *Status of Surveys*

Status	#
Printed	49
Returned	13
Useable	12 (40% of the 30 identified businesses)
Done in person	6
Returned by mail	4
Returned by email	2
Recovered from box	5
Incomplete	2
Unaccounted for	27 (55%)

The primary author used accounting software from his previous business efforts to complete the survey in approximately one hour per fiscal year. Monetizing incentives for otherwise non-respondents to participate would likely approach $50 or more per survey. Given the inferred profile of the non-respondents, this would likely mean paying an otherwise non-respondent $50 to report that their business spent little or no money locally. As will be discussed, the developed model posited that non-respondents would have all of their expenses leaving the community, so monetizing an incentive would not be likely to yield any additional information.

The absence of twenty seven out of forty nine surveys is strongly suggestive of a high level of community interest in the survey. Although seventeen of the thirty identified Dunster businesses declined to participate in the survey, there is no reason to assume that they account for the majority of the missing surveys. Rather, these surveys were likely picked up by community members that did not own businesses, only to realize they were not targeted for the survey. The primary author received first-hand many comments indicating an interest in mapping out personal expenses. Businesses that could not provide the data may account for a percent of the missing surveys. Unfulfilled commitments to complete the survey account for six of the missing surveys.

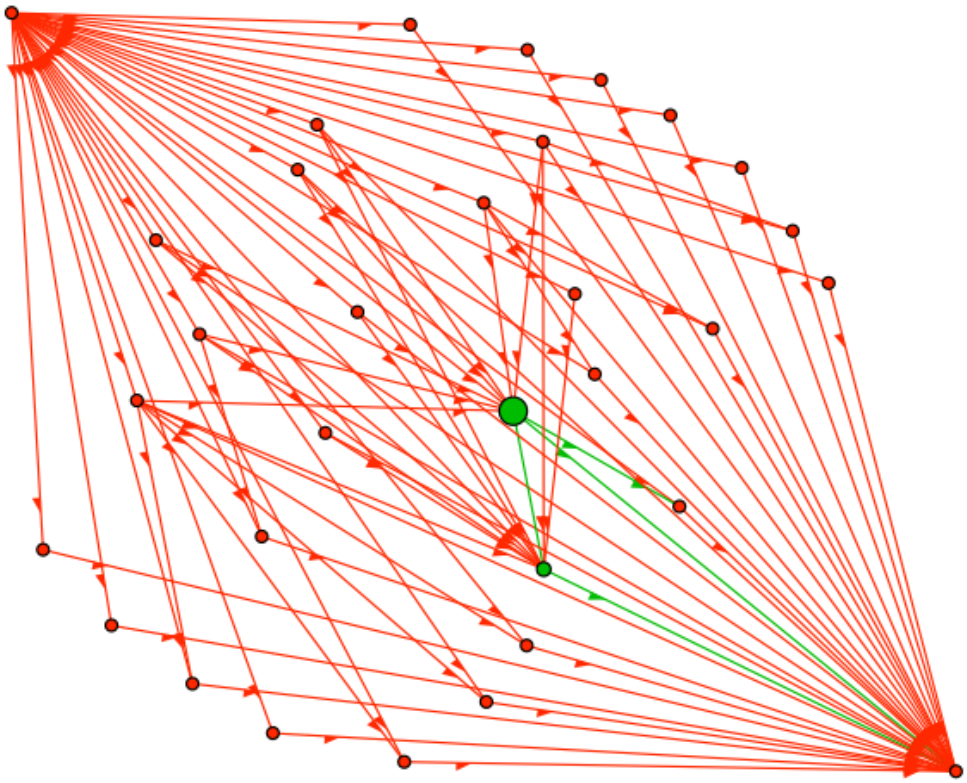
3.0 Results and Modeling

3.1 Social Network Analysis: Methodology

The primary author imported the collected data for the Dunster economy into the social network analysis software Gephi (http://www.gephi.org), and used this software to render a map of the Dunster economy (see Figure 3.1.1). The arrangement of the network was done manually, with an eye more towards aesthetics than any other attribute. The circles are individual businesses and the lines represent

paths that currency takes, as expenses of the businesses. The circle in the upper left corner represents the dollar entering the economy from outside the community, and the circle in the lower right corner represents the dollar exiting the community economy.

Figure 3.1.1: Map of Dunster Economy.



During analysis, the primary author realized that permission to include the business name in the map was not asked in the survey. There is some evidence that a few businesses were participating with an expectation of anonymity. As a result, all publicly available data omits the businesses' names.

The betweenness centrality attribute from social network analysis (Knocke & Yang, 2008) determined the size of the circles of business in the map in Figure 3.1.1. The smaller of the two green dots represents the unified node used for representing Dunster residents, as an expense in the form of salary or other payment for services rendered. As documented above, no personal expenses were solicited, so 100% of the expenses of the Dunster residents are assumed to leave the community. Additionally, any identified business that did not participate in the survey was also assumed to have 100% of its expenses leave the local community economy. This approach was deemed preferable to making inaccurate estimates. It is also likely consistent with reality - the businesses not participating may have done so because they did not spend any money locally and therefore had nothing to contribute to the survey.

3.2 Social Network Analysis: Qualitative Analysis

A visual inspection shows the economy of Dunster to largely be of direct flow, with no identifiable loops. Money appears to pass through Dunster, with a small

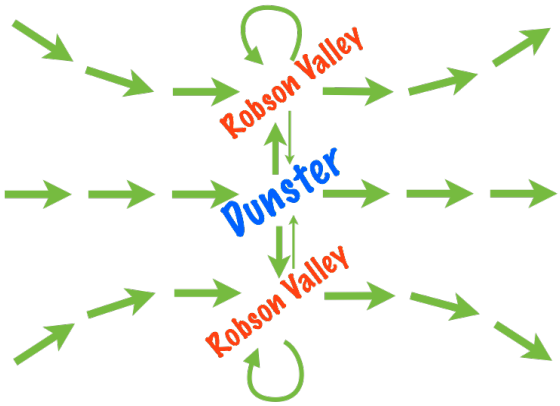
amount of local expenditures. This is consistent with the survey results, in which businesses identified external expenses such as insurance, bank loans, taxes, and products for resale as their largest percentages of expenses. Quite simply, there is very little capacity in Dunster to provide services or products to other businesses in Dunster. There are at least two businesses in Dunster that do provide services and products to Dunster businesses, but they did not participate in the survey. The balance of businesses provide and obtain services and products outside of the Dunster area.

There is an additional component to capacity, in that many businesses in Dunster had difficulty participating in the survey because they still used paper and pencil for bookkeeping. This "old school" accounting method tracked expenses by category (e.g., gas), not vendor. Converting from category to vendor for a report with computer-based accounting is not a difficult nor a time-consuming task. This can be done by sorting on vendor instead of the default “category”. However, it is rather time consuming when done on paper ledgers (but not impossible, as the primary author did this in person with two Dunster businesses).

With the lack of business capacity, it is difficult to see the DCFS obtaining secondary economic benefits from their community forest operation. This has been a challenging question posed by at least one critique of community-based natural resource management (Bradshaw, 2003). While DCFS will be able to fund several community group efforts, and there may be some indirect benefits to local businesses through this, it seems unlikely that Dunster businesses will be able to capture direct economic benefits from the community forest. Conceivably, DCFS will be able to provide reliable fiber to small mills in the Robson Valley. While this will benefit the expanded local economy, there were no specifically-identified mechanisms in which money would flow back into Dunster from this arrangement.

Figure 3.2.1 graphically represents the flow of currency into the community of Dunster and surrounding areas. Currency flows into the Robson Valley northwest and southeast of Dunster, and into Dunster itself. Of the currency that flows into Dunster, it leaves either to the northwest or the southeast into the Robson Valley, or to parts beyond such as the Lower Mainland or Alberta. Of the currency that flows into the northwest and southeast parts of the Robson Valley, there are some communities in which it may recirculate, and a small amount may flow into Dunster. In general, though, the currency that flows into the Robson Valley flows back out.

Figure 3.2.1: Currency Flow in Dunster.



3.3 Income Modeling: Methodology

As business incomes were not solicited, the primary author constructed two models to provide a range of possible values of each business' income as a percentage of the total expenses of the outside source of income into the community. These models randomized the distribution of incomes to the businesses from outside the local community. This distribution used an algorithm from Weisstein (n.d.) to generate a Gaussian (normal) distribution. One model generated a spread of income such that the peak value was 0.072, or 7.2% of the total income into the community, while the least value was 0.0002, or 0.02%. This 360:1 ratio represents a distribution of incomes from $1500 to $540,000, a range the primary author believes is realistic based on conversations with business owners. However, this may also represent a more narrow concentration of income than may exist in the community.

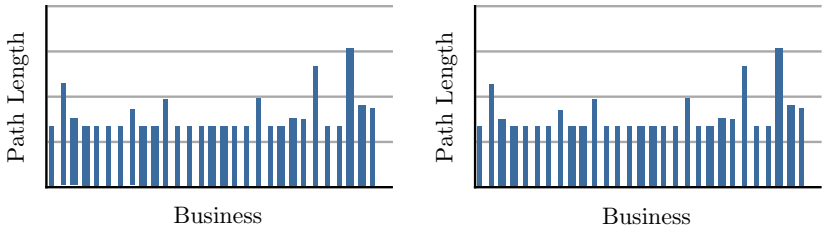
The other model used a 36:1 most-to-least ratio, representing an income range of $5000 to $180,000, which is likely high at the low end ($5000), and low at the high end ($180,000). However, this distribution is probably more likely near the middle of the spread than the previous range (i.e., the income distribution is probably not truly "normal"). Using the method documented in the companion article by the authors, "Quantifying Equity with Messrs. Markov, Lorenz and Gini: Retaining and distributing benefits in natural resource-dependent communities," in this issue of JRCD, the Gini Coefficient for the 36:1 ratio is 0.429 and for 360:1 ratio the Gini coefficient is 0.561. Given that some of the participating businesses were as small as individuals selling vegetables from their gardens, these are reasonable estimates of the distributions of incomes. Figure 3.3.2a shows the shape of the income distribution used to model business incomes. The ratio affects the width and relative height of the curve. A higher ratio has a higher relative peak and a narrower width, which represents a greater concentration of income among only a few businesses.

In order to avoid a bias where the businesses with the longest transaction chains also received the highest percentage of income, the modeled income distribution was rotated through multiple permutations against random organization of the business listings. Figure 3.3.1 shows a random organization of businesses against which the income distribution is modeled. Figure 3.3.2b shows the income distribution after several rotations.

The rotations move the peak of the income distribution once for each business. Visually, this is seen as the maximum incomes in Figure 3.3.2b are modeled as occurring at a different location in the set of businesses in Figure 3.3.1, compared to Figure 3.3.2a. Rotating the modeled peak against all locations flattens any clustering effects in the data and is hypothesized to produce a realistic calculation of the high and low average number of transactions for the community's economy. The actual number is somewhere in between those high and low numbers.

For a more in-depth discussion of the methodology, please see the companion article by the authors, "Social network analysis, Markov Chains and input-output models: combining tools to map and measure the circulation of currency in small economies," in this issue of JRCD.

Figure 3.3.1: Random Distribution of Path Lengths



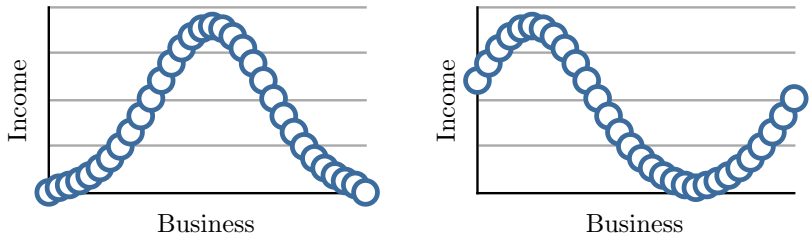


Figure 3.3.2a: Modeled Normal Distribution of Incomes.

Figure 3.3.2b: A Rotated Permutation of the Normal Distribution of Incomes.

3.4 Average Number of Transactions (Markov chains): Quantitative analysis

The primary author used custom written software initially (and later used spreadsheet software) to take the data for the Dunster area economy and determine the average number of times a dollar circulated within Dunster before leaving the community economy. The primary author crafted the surveys into a Markov chain-style matrix and used matrix operations to determine the average number of transactions that occurred from the time a dollar entered the community until it left the community, as well as the number of transactions for a dollar departing from each business before it left the community. Different models were used to examine a range of scenarios. See the companion article by the authors, "Social network analysis, Markov Chains and input-output models: combining tools to map and measure the circulation of currency in small economies," in this issue of JRCD, for an in-depth explanation of the methodology.

Ultimately, the economy of Dunster shows little ability to capture dollars as they pass through, and the 360:1 model shows that on average, the number of transactions from outside the community into the community and then back outside again is highly likely to be between 2.04 to 2.24 transactions, with an average of 2.14. The lowest possible number of transactions is 2.0, as one transaction is the currency being received by a Dunster business, and then one more by that business spending it outside the community.

Table 3.4.1. *Average Number of Transactions in Dunster*

Model	360:1	36:1
Measured	2.04 - 2.24	2.06 - 2.22

3.5 Equality Gini Coefficient: Methodology and Analysis

The primary author used the survey data to calculate the individual business Gini Coefficients (G) for their expenses, and then, using E=1-G, their equality Gini Coefficients were calculated. The coefficients were calculated for the distribution of each business' expenses, including exiting the community. See the companion paper by the authors, "Social network analysis, Markov Chains and input-output models: combining tools to map and measure the circulation of currency in small economies," for a discussion of the "equality Gini Coefficient," and "Appendix B," in the same paper for a discussion of how to use spreadsheets to calculate Gini coefficients.

Not surprisingly, the Gini Coefficients were high (and conversely the equality GCs were low) for all of the businesses. There are few opportunities in Dunster for businesses to acquire services and goods locally. However, a few businesses did make localization an express goal and performed better than the other businesses. There was a correlation between these businesses and their owners being noted within the community of Dunster as "community leaders," although this did not correlate with the size of their business financially.

3.6 Combined Equity Calculations

Table 3.6.1 shows the ranking of the Dunster businesses as measured by multiplying the average number of transactions before their dollars leave the community by their equality Gini Coefficient (the businesses were numbered after their transaction lengths were calculated). The scale (size) of these numbers is not relevant; this is an artifact of multiplying two small numbers together. Although it was not done for this analysis, the eGC or the equity contribution could be scaled using division by the largest number of that value, in order to obtain numbers that are more familiar to community members. For example, if Business 26 were used as the scaling value, its eGC could be scaled to 1.0 (by dividing by 0.0625) and then its equity contribution would be 1.4135, in comparison to Business 28, which would have a scaled equity contribution of 0.9129, or approximately 2/3 the equity contribution of Business 26.

The longest chain does not necessarily mean the greatest contribution; in this case (Business #30) all of the expenses from the business were captured by a sole Dunster resident, leaving an equality GC of 0 and a total contribution measurement of 0. The business with the largest contribution to the community (#26) had only the fifth longest transaction chain, but the proprietor made an effort to source locally whenever possible.

The eGC of 0 for the business owner that captured all of expenses (through profit) raises an interesting question. This value is equal to all of their expenses leaving the community, which may or may not be reflective of the individual's community values (in this case, it does not, as the business owner spent locally as much as possible for personal expenses). It does reflect the concentration of benefits, though. A possible mechanism to address this in the mapping could be for the profit to be recaptured by the business itself, or for separate nodes to represent business owners.

Table 3.6.1. *Businesses Ranked as a Contribution to the Community*

Business #	Transactions	eGC	Equity Contribution	Business #	Transactions	eGC	Equity Contribution
26	1.4135	0.0625	0.0884	5	1.0000	0.0000	0
28	1.5547	0.0367	0.0570	6	1.0000	0.0000	0
25	1.3547	0.0333	0.0452	7	1.0000	0.0000	0
27	1.3766	0.0293	0.0404	8	1.0000	0.0000	0
29	1.7681	0.0176	0.0311	9	1.0000	0.0000	0
24	1.2690	0.0184	0.0234	10	1.0000	0.0000	0
23	1.2100	0.0140	0.0169	11	1.0000	0.0000	0
22	1.1345	0.0119	0.0135	12	1.0000	0.0000	0
21	1.1001	0.0067	0.0073	13	1.0000	0.0000	0
20	1.0940	0.0065	0.0071	14	1.0000	0.0000	0
30	2.0000	0.0000	0	15	1.0000	0.0000	0
1	1.0000	0.0000	0	16	1.0000	0.0000	0
2	1.0000	0.0000	0	17	1.0000	0.0000	0
3	1.0000	0.0000	0	18	1.0000	0.0000	0
4	1.0000	0.0000	0	19	1.0000	0.0000	0

3.7 Data Gaps

Most of the identified businesses in Dunster did not participate in the survey. As per the established rules, these businesses were assumed to have 100% of their expenses exit the community on the next transaction (as shown by a "1" in the transactions column of Table 3.6.1). Only one business that participated had 100% of its expenses leave the community. Of the remaining businesses, most of their expenses did leave the community on the next transaction, but some percentage did get paid out to their owners (as Dunster residents) or to other Dunster businesses. One business had all of its dollars spend an additional transaction within the community, albeit through the salaries paid to Dunster residents.

The impact of non-response survey bias is likely to be minimal. Due to the small scale of the economy in Dunster, additional responses from businesses are not likely to reveal any loops, nor are they likely to improve the overall numbers. Additional responses would likely reinforce the low number of transactions.

An unknown factor is the so-called "underground economy," where exchanges are through barter or other "off the book" transactions. Potentially these may contain some loops, but overall the impact of the underground economy in Dunster is unlikely to be high, simply due to the nature of the transactions. Typically, according to locals, underground transactions tended to be an exchange, such as trading a chicken for some vegetables.

3.8 Presentation of Results to Dunster Community

The results were presented to the Dunster community at-large on Oct. 14, 2012, at the first "Carbon, Climate Change, and Community Forests (C4F)" conference, held in the Dunster Fine Arts School and Conference Centre (http://www.c4f.ca). Over the two day conference, Dunster community members were able to attend 14 presentations by 13 unique presenters, ranging from graduate students and

university professors from the University of Northern British Columbia and Simon Fraser University, to representatives of the local community forests and researchers from the Ministry of Forests, Lands and Natural Resource Operations. One consistent theme from discussions with community members about the results was their surprise that the number of transactions was so low. This should be viewed as a rejoinder against subjective estimations of how often currency circulates locally in a community.

4.0 Equitable Distribution of Benefits in Community Forests

The largest economic benefit of a community forest is the access to the timber, whether through logging contracts or leasing cutblocks. An additional economic benefit, albeit much smaller, is the distribution of grants to community groups. For community forests legally structured as corporations, there may be dividends paid to the shareholders.

As can be seen in the map of the economy of Dunster, the technique used in this paper shows both where benefits flow and where they do not (a reminder to the reader that logging had not yet begun in Dunster at the time of the surveying). In communities with limited industrial capacity such as Dunster, capturing the bulk of (or even a small part of) the economic benefits of natural resource extraction is challenging.

Capturing the benefits requires balancing maximizing the value received from the natural resource in raw form versus providing local opportunities for value-added processing. Looking purely at price alone overlooks distributing the benefits equitably through contributions to the local economy, in both depth and width. This social dilemma is an added challenge to community-based natural resource management. The technique used in this paper allows said communities to establish a benchmark to compare themselves against and quantify their progress towards increasing the equitable distribution of benefits, and by extension, the sustainability of managing the natural resource.

Additional discussion of this issue can be found in the companion article by the authors, "Quantifying Equity with Messrs. Markov, Lorenz and Gini: Retaining and distributing benefits in natural resource-dependent communities," in this issue of JRCD.

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