Financing hard commodity supply chains

Evaluating opportunities in the value segments of aluminium, copper, thermal coal and zinc chains.

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Management summary

Background

This report presents the thesis research of the author which overlaps with an assignment initiated by ABN AMRO Global Commodity Finance. The central focus of the research is on the financing of hard commodities' supply chains.

Objectives

The objectives of the research strive to create value for the bank and the university by:

- Increasing and communicating the knowledge of hard commodity supply chains within the bank
- Advising on the business opportunities for ABN AMRO Global Commodity Finance in the commodity industry
- Researching the interface between supply (value) chain and finance.
- Evaluating several decision supporting tools for a real life problem

Approach

The problem formulation is foundation of the research and was developed to reflect the practical goals of the bank and the academic goals of the university.

The formulation is: *How can strategic choices be supported when comparing commodity finance opportunities in supply chains and which of these opportunities should be the long-term focus of ABN AMRO?*

This formulation is broken down in research question within four themes:

1. Commodity finance opportunities
2. Choosing between opportunities
3. Chain analysis
4. Advice on the choice between the case studies.

The research focuses on the commodities aluminium, copper, thermal coal and zinc, which will be used as case studies. The scope of the analysis begins at the mining operations and ends before the commodity is consumed.

The research questions will be answered per theme, in the following sections.

Conclusion 1. Commodity Finance opportunities

Financial riskier companies with ownership of commodity inventory

The added value of commodity finance can particularly be attributed to the risk mitigating structures. These structures decrease the risk for the bank and improve their risk-adjusted-return on capital. The structure ensures that the bank can claim the commodities in case of a default. This implies that the pricing of a loan can be lowered by the bank, which makes this type of finance attractive for specific companies. The commodity finance structure mitigates the repayment risk (linked to the ability of a company to repay its loans) to a performance risk (linked to the ability of a company to produce goods). Financially riskier companies are likely

to be more attracted to commodity finance, because of their high repayment-risk but essentially lower performance risk. Therefore, the financial riskier companies with the ownership of commodities are seen as the best opportunity for commodity finance.

Every new deal with a client of a commercial banking product has to follow a certain process. The first step of this process is the business development of the bank. In this step, the bank defines in which markets it wants to be active with which clients and in what role. For instance, by formulating the ambition to enlarge the business with current client but also by searching for new business. During this step, strategy towards opportunities can be formulated. This can be done from various viewpoints. This research aims to enhance the views on opportunities in the market, mainly from a finance and supply chain perspective.

Conclusion 2. Choosing between opportunities

Evaluation of opportunities..

When choosing between several opportunities, an evaluation on key criteria is needed. It was decided to develop a multi-criteria decision model to support this decision.

..viewed on the level of value segments ..

Opportunities can be evaluated on three levels: company, (value) segment and commodity. A company can be involved in several segments of various commodities, for instance a company involved in copper mining, aluminium mining and refining. Current opportunities are searched on commodity and company level. Company level research (due diligence) is a time and resource consuming process and not suitable for searching opportunities. Commodity finance is a niche product within finance, looking purely on commodity level will not give enough insight on opportunities.

With this segment view, over 300 commodity companies were summarized in eight alternatives, which clearly had practical advantages over company level research. Foundation of this segment view was found in academic literature. Opportunities varied between segments within the commodity chains, underlining the importance and added value of the segment view compared to the commodity view.

Making an analysis on segment level is therefore preferred for a first scan. However, this can not replace the due diligence which is needed in the credit process. Segment level analysis is expected to add value to the strategic business development process.

..scored on finance and supply chain criteria

For the evaluation of the segments, two themes are chosen, in which criteria were generated by using decomposition:

Inventory ownership:

1. *Leanness of supply chain*. Companies with lean supply chains own less inventory and have shorter cash-to-cash cycles. This implies that there is less inventories (or receivables) available for securing a loan and less working capital financing need.

2. *Exchange inventory*. When the commodity future price exceeds the today cash price, there is an incentive to build-up inventory, which needs financing. This criterion is based on statistics of the specific commodity exchange.

Access to other financing products:

3. *Margin*. Companies with healthy cash flows have more excess to other financing sources than commodity finance. A value chain analysis is used to gain insight in the structural differences in margin of the segments.
4. *Fragmentation*. Markets with higher fragmentation are more interesting because of their higher risk profile. A fragmentation index is calculated per segment.
5. *Vertical Integration.* Vertically integrated companies are less interesting because intra-company trade does not use external traders and integrated companies are less risky. Integration is determined by quantifying the metal balances per company.
6. *Value of production*. Transactions and markets need to have a certain mass to become interesting. This criterion is based on statistics.

Decision model for weighted trade-off

In this research, the six criteria were quantified and outcomes were calculated for the aluminium, copper, coal and zinc segments. This generates an evaluation table where the alternatives (i.e. segments) are scored on the criteria. A paired comparison model was build to facilitate the trade-off between the alternatives based on weighted criteria. This was done because the criteria, according to the interviewed experts, differ in importance. The model calculates the preference order, which implies that the alternatives are ranked on their possible opportunities for commodity finance. This ranking was more precise than ranking based on algorithms.

Dependence on precise statistics

The outcomes of the model are highly dependent on the right statistics, which are not always available. No matter how reliable the model; if the inputs are wrong or not precise the outcomes loose their value.

Conclusion 3. Analyzing chains

C2C, VCA, VIMI

The inputs for the decision model were derived for various analyses of the commodity chain, most were drawn from academic literature but the index for vertical integration was developed during this research . The most valuable for future use in the banking world are:

- *Cash-to-cash cycles (C2C)*. To give insight in the working capital needs of segments in a chain. Interaction between segments can also be analysed. This links finance to supply chain science.
- *Value-chain analysis (VCA)*. VCA is used for deriving: added value per step, attitude towards raw material procurement and thus inventory levels, relative value density of goods and raw materials, the margins.

- *Vertical Integration Metal Index (VIMI)*. Knowing how integrated a segment is a valuable insight. Understanding the inter-company trade in raw materials and finished goods is key.

Conclusion 4. Preference order of case studies

In the table below, the commodity segments are evaluated on the criteria.

	A1	A2	A3	A4	A5	A6	A7	A8
	Al mining	Al refining	Al smelting	Cu mining	Cu smelting	Zn mining	Zn smelting	C mining
C1 Leanness Supply Chain	lean	medium	medium	lean	medium	medium	medium	lean
C2 Exchange inventory	0,0%	0,0%	0,7%	0,0%	-4,2%	0,0%	1,1%	2,1%
C3 Margin	29%	30%	44%	24%	3%	10%	4%	8%
C4 Fragmentation	992	661	538	527	432	437	325	218
C5 Vertical integration	7%	20%	21%	44%	44%	43%	43%	85%
C6 Value (bn USD)	1,5	12,8	45,5	37,7	45,5	7,5	10,6	240

Next, the case studies will be introduced and these outcomes will be discussed.

Case study: Aluminium

General. Aluminium is mainly used in transportation and construction industry and is relatively lightweight. High purity aluminium is traded on exchanges like the London Metal Exchange (LME). The aluminium chain can be broken down in three segments: Bauxite mining, alumina refining and aluminium smelting.

Highly integrated and concentrated

Evaluation on criteria. The supply chains of the aluminium companies show the same characteristics as in the copper segments. The aluminium mining segment has a lean supply chain while refining and smelter score medium. The aluminium market is currently in a small contango. Margins in aluminium are high with which is illustrated by the aluminium segments scoring the top three positions in the comparison. Fragmentation and integration are the highest in the sample, implying low scores on these criteria. The value of production increases dramatically downstream. The biggest value step is in (energy intensive) smelting. Bauxite seems to be the worst segment from the viewpoint of commodity finance because of the 4 eighth places on six criteria.

Case study: Copper

General. The conductivity (of heat and electricity) of copper explains its popularity in the electricity and construction industry. High purity copper is traded on exchanges like the London Metal Exchange (LME). The copper chain can be segmented into mining, smelting and refining. Because of the high level of integration, smelting and refining can be seen as one segment.

Average scoring accept backwardation

Evaluation on criteria. The supply chains of copper are similar to the results of aluminium, showing lean supply chains at the mines and medium at the downstream refiners. Currently the copper market is in backwardation; therefore it has the lowest score on criterion 2. Smelting margins are very thin, but this can be rather volatile due to inter-company negotiations. The level of fragmentation is certainly higher than the aluminium market and

slightly more than the corresponding zinc market. Vertical integration is less than aluminium market and comparable to zinc market. The value of production is quite comparable between the mine and smelter, which contrast greatly with the aluminium chain. In other words, the copper concentrate is relative valuable and the value step of smelting-refining segment is not large.

Case study: Thermal coal

General. A quarter of the global electricity generation is done by firing coal, therefore, the energy sector is the largest consumer of coal, although other applications (e.g. steel production) need coal as well. Coal can be sub-divided into several ranks, dependent on moisture and energy content. Each rank has its preferred applications but there are overlaps as well. Some coal-ranks are exchange traded (e.g. on the Nymex). Thermal coal reserves are roughly 60% of the global fossil energy reserve indicating the long-term dependence on this fuel.

Fragmented, not-integrated and large market but lean supply chain

Evaluation on criteria. Just like the other mines, coal miners have quite lean supply chains. Historical margins of the peer companies were small but rather volatile, and under influence of various dynamics (e.g. oil prices). Fragmentation is very low in this segment with an HHI of 218. Vertical downstream integration with power-plants is also limited. But, very long-term contracts (up to 30 years) perform an almost similar role. The total value of the production (± 240 bn USD) gives a clear indication about the large size of the market.

Case study: Zinc

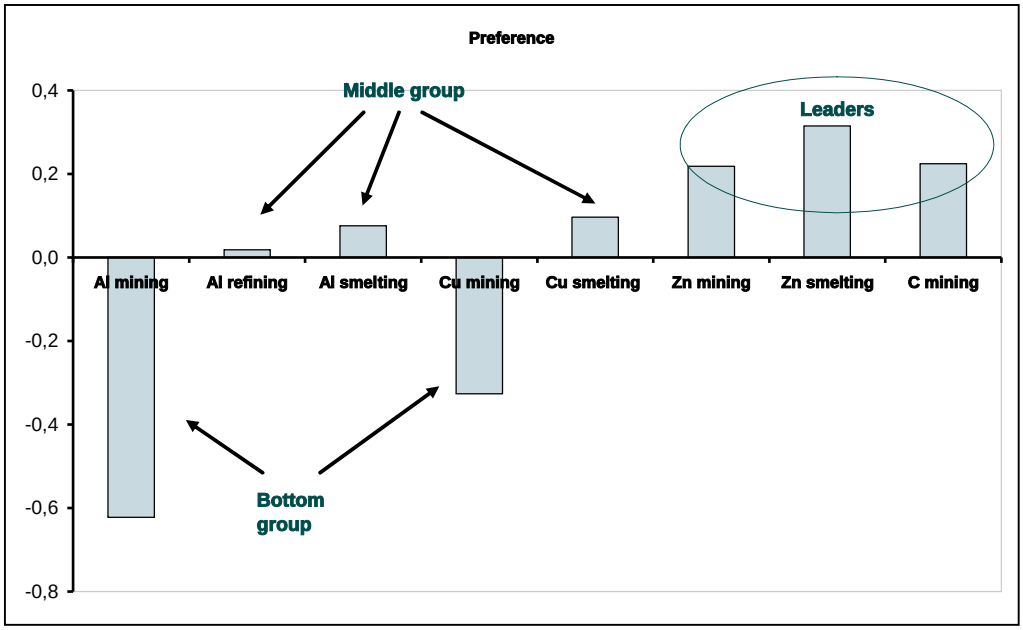
General. Zinc is mostly used to protect steel from corrosion and to produce brass and bronze. High purity zinc is traded on exchanges like the London Metal Exchange (LME). The zinc chain is comparable to the copper chain and is sub-divided into mining and refining value segments.

Scoring high on all criteria but relative small market

Evaluation on criteria. The supply chain of the zinc mine is the only medium scoring mine. The smelting segment's supply chain is medium which is in line with the other supply chains of smelters. The Zinc market is currently in a contango which could influence trading inventories. Mining margins are less than other "metal" miners. Smelting margins are comparable to copper smelters. Integration is roughly equal to the copper market. On pure market size, zinc is relative small.

Advice on preference for which case

To develop a preference order between these opportunities, a decision model was build. This model compares the preference order per criterion. These scores are adjusted for the weights of the criteria and summed. These results are summarized in following graph.



The best scoring alternatives were zinc smelting, zinc mining and thermal coal mining. The middle group consisted of copper smelting, aluminium smelting and aluminium refining. copper mining and especially aluminium mining scored the lowest preference.

After these conclusions have answered the research questions, the recommendations are addressed.

Recommendations

The recommendation of this research are of a practical nature and aimed and the bank.

- Use case-study preference order for strategic choices
- Update statistics and strategy regularly (e.g. every 6 months)
- Use supply chain and financial criteria for evaluating opportunities to enrich decision process
- Continue to perform studies on cash-cycles, value chain and vertical integration
- Continue research on other hard commodity chains, mainly: aluminium alloy, lead, North American Special Aluminium Alloy, Nickel, Tin, Plastics, oil, gas, propane, gold, silver, platinum, palladium
- Financial risks cause by supply chain position can be seen as opportunity. Companies in a difficult position in the chain are opportunities
- Leverage the supply chain-network. Use positive relation with current clients to enhance relationships with up and downstream companies.
- Use bottom-up management approach to use bankers expertise on commodity market
- Use internal information and know-how of different departments within the bank