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RESOURCES & WASTE UK

Championing the future of resource management

Managing the Risk from Secondary Raw Material Price Movements - Technical Appendix

September 2015

Introduction to Resources and Waste UK

Resources and Waste UK (R&WUK) is the recently created partnership between the Chartered Institution of Wastes Management (CIWM)[1] and Environmental Services Association (ESA)[2]. It is a unique partnership of the professional institution and trade association at the heart of the sustainable resources and waste management industry in the UK. It has been created to form a single voice in the interests of championing the future of resource management.

This Technical Appendix has been prepared by Eunomia Research & Consulting for R&WUK.

[1] CIWM is the professional institution for the UK's resource and waste management sector. It has approximately 6,000 individual members based predominantly in the UK, 2,500 of which are Chartered Waste Managers

[2] ESA is the trade association for the UK's resource and waste management sector. We work with our members to transform waste and resource management across the country. This work helps enable our members to turn Britain's waste into valuable resources, whilst continually protecting the environment.

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Glossary of Terms

Term	Meaning/ Definition
Exchange Market (Electronic Exchange)	A physical or electronic marketplace in which financial instruments (such as securities, derivatives etc.) can be traded. The exchange usually manages the terms of orderly and fair trading among both direct and indirect participants, and provides price information for the securities traded on it.
Forward Contract	These are private agreements between two parties to buy and sell a particular quantity of an asset at a predetermined price on an agreed date in the future. Importantly, these are not guaranteed, and so there is a risk of either party defaulting on the contract. Delivery of the asset or cash settlement usually takes place.
Futures Contract	Commonly referred to as 'futures'. These are legally binding agreements between two parties to buy and sell a particular quantity of asset at a predetermined price, on an agreed date in the future. Importantly, delivery of the asset is guaranteed by a **Futures Exchange.** Due to the participation of indirect (financial) traders, and because the mechanisms are used as a means to establish some certainty in terms of sales revenue, physical delivery, or purchase, of goods usually occurs for a small proportion of trades.
Futures Exchange	A financial market on which people can trade **Futures Contracts.**
Hedger	Typically the buyers and sellers of the relevant commodity, who are seeking to protect themselves from the downside risk of adverse commodity price movements. They are usually seen as risk-averse. Conversely, see **Speculator.**
Hedging	Refers to a strategy for reducing the exposure to risks associated with high price volatility in a particular financial asset or commodity. This risk management strategy essentially involves the transfer of risk from hedgers to speculators. Hedging can be conducted using various financial instruments, such as forward contracting, futures, options, swaps, etc.
Market Trade Board	For the purposes of this report, these are web-based exchanges/ brokerage services in which direct participants (buyers and sellers) are allowed to submit quotes and execute trades through an electronic system. Clearing and settlement of trades are left to

Term	Meaning/ Definition
	the direct participants.
Options	A financial derivative giving its buyer the right, but not obligation, to buy/sell a security at a predetermined price either in a specified period of time, or on an agreed date in the future.
Over-the-Counter (OTC) Trading	Defined by the NASDAQ as: "A decentralised market (as opposed to an exchange market) where geographically dispersed dealers are linked by telephones and computers. The market is for securities not listed on a stock or derivatives exchange".
Speculator	Typically risk-loving traders of financial instruments. They engage in high-risk financial transactions in order to try and profit from anticipated price fluctuations. Conversely, see **Hedger.**

1.0 Introduction

This technical appendix which accompanies the Resources & Waste UK report 'Managing the Risk from Secondary Raw Materials Price Movements is intended to provide more detail regarding the role that financial instruments could play in the management of Secondary Raw Materials (SRM) price risk.

The SRMs that are considered include the following grades of post-consumer household recyclables:

1) Paper/card (soft mixed export grade, news and pams);
2) Metals (aluminium and steel cans);
3) Glass (container cullet); and
4) Plastics (PET, Natural HDPE).

Post-consumer textiles were not included in this analysis as this market is primarily a re-use one, with 2010 figures showing only approximately 8% of post-consumer textiles collected for re-use/recycling being used for recycling.[3]

2.0 Price Setting

Understanding existing price setting mechanisms and the level of transparency of these mechanisms for each of the relevant SRMs can be important in terms of understanding how price fluctuations might be addressed using financial instruments. In this section, the question being addressed is how the price is determined between the buyer and seller, and with reference to what (if any) price indices / movements.

Such mechanisms are complex and vary between the specific SRMs. As with any commodity, prices are influenced by interplay between supply and

[3] WRAP and Oakdene Hollins Research and Consulting (2012) *Textile Flows and Market Development Opportunities in the UK*, September 2012. Note that this situation may change in future as recycling opportunities develop.

demand; for SRMs in particular the relationship between the various SRM markets and their respective primary material substitute markets is an important consideration for price formation.

In order to try and understand the factors affecting price discovery and formation for the various SRMs, a brief review of secondary literature was undertaken, together with interviews with a number of reprocessor representatives. This research identified some of the factors influencing price setting on a material by material basis including:

- The availability of reliable and transparent sources of price information. Ideally, bid and offer prices, as well as those prices agreed for ongoing market transactions, inform buyers and sellers as to the state of the market at any given time. The visibility and reliability of such information varies across the different commodities. The less information of a reliable nature exists, then the more likely it becomes that prices are agreed on a bilateral basis, though usually, this takes place with some reference made to price information, even though this might not always represent information related to specific transactions (and might not always be up to date);
- Level of domestic competition and dependence on export markets (and therefore exposure to foreign competition;
- Existing stock levels;
- The nature of competition, whether this is from the primary commodity of the same material, or other commodities.

Having acknowledged the importance of the value of primary raw material substitutes in price setting we have examined the degree to which historic SRM prices correlate with those of primary substitutes (where relevant) in Section 4.0.

3.0 Review of Previous Experience with SRM Trading Floors / Futures Markets

In order to inform the discussion on the suitability of using exchange-traded futures markets and related mechanisms for managing SRM price risk in the main report, both past and current examples were reviewed using publically available literature sources.

Where information was unavailable or where there were no examples of past or present SRM futures markets found, references to markets for the related primary materials' finished products were reviewed, as were case-studies of online market bulletin boards (or web-based listing services, including Over-the-Counter (OTC) traded instruments) and independent providers of market information (particularly price indices).

3.1 Market/ Price information Providers

Section 2.0 mentions the use of a variety of price indicators (e.g. LME, Platts etc.) as the basis of reference for contractual price agreements among buyers and sellers of SRM. Successful futures trading requires the development of transparent prices (based on actual transactions), which can then be used by the wider industry.

When considering the development of futures markets for SRMs, spot indices provide the physical market (or spot market) prices with which prices quoted by new futures markets aim to converge at contract maturation. Secondly, they provide the underlying market price for an asset at which futures contracts are eventually settled – spot market indices are essentially representative of the floating market price to which the futures market aims to limit exposure. The third and most crucial function that price indices provide to the futures market is transparency in pricing information.

Given these three functions, a prerequisite for the establishment of any successful futures contract is the existence of robust and reliable prices, or price indices, in the spot market. Note that this need is heightened for direct participants (buyers and sellers of the material itself), for whom the accuracy

of quoted price levels are of concern for physical settlement, as opposed to financial transactions purely for speculative purposes (for which only the quoted relative price change is of importance).

However, in the absence of transparent exchange-linked prices, as in the case of the majority of SRM markets, a number of private organisations conduct market analysis and publish price data that may be used as a benchmark for contractual agreements between trading parties. Recognised global indices of this kind for SRMs include Platts (Alumina Index for aluminium and The Steel Index for steel), and FOEX (PIX recovered paper index).[4, 5] Regionally recognised indices like EUWID (for pulp and paper) are additionally in use.[6] In the UK, recognised local indices include Letsrecycle, and the WRAP Materials Pricing Report.[7, 8]

These organisations do not run trading floors or exchanges of any kind, and information is based on prices (bid/ offer/ closing) reported by buyers and sellers. Though such spot prices are useful, they may be unreliable when compared to financial trade exchange-linked indices, as they are dependent on the number of interviews undertaken, as well as the specific parties interviewed, and are rarely representative of the entire market of interest. In addition to this, buyers and sellers may be incentivised to quote prices that are either lower (in the case of buyers) or higher (in the case of sellers) than the actual transacted price in order to manipulate the index in a manner favourable to them, whilst the fact that quoted prices are not linked to actual trades may mean that the reported data 'lags' the prices being achieved in the market. Data gathering and indexing methodology is therefore crucial to the efficiency of such price information, but the possibilities for completely eliminating bias are limited.

[4] http://www.platts.com/
[5] http://www.foex.fi/
[6] http://www.euwid-paper.com/
[7] http://www.letsrecycle.com/prices/
[8] http://www.wrap.org.uk/content/materials-pricing-report

3.2 Market Exchange Boards (Web-based Listings)

While the price information considered in Section 3.1 is provided by organisations that have no direct link to actual trades of SRMs or associated financial instruments, others currently in use, such as the Plasticker and PlastEurope Indices (for plastic), are managed by material trade boards themselves.[9, 10] Such bodies derive price information from the bid and offer data listed, and in some cases, from transacted, or closing prices reported by their members. These exchanges do not trade in financial derivatives. The ScrapIndex, for example, compiles prices from internal proprietary data generated on the Recycler's Exchange, which is a part of the cooksmill.net affiliate network (including other such web-based markets such textilefiberspace.com).[11, 12, 13, 14] Such networks are usually web-based, and function as a meeting place and bid/offer listing board for global buyers and sellers of recycled materials. Actual negotiations are usually conducted over the telephone or email between parties, and not on the exchange itself.

The range of services offered by such markets varies from market to market – The Environment Exchange's recovered paper market, for example, does not publish a price index, but offers price information to its members, who are additionally provided with material quality and delivery specifications for collected and delivered contracts traded.[15]

Although such trading boards appear to be popular in the U.S.A and Canada (and some evidence suggests they are used in European countries as well), they seem most often to be used as a market of last resort, a source of market information, and to list one-off bulk trades rather than day-to-day transactions. Furthermore, although a high volume of bids and offers may be listed, the number of transacted deals resulting from these listings is not always high. This was the case also with the Chicago Board of Trade's

[9] http://plasticker.de/preise/
[10] http://www.plasteurope.com/
[11] http://www.scrapindex.com/
[12] http://www.recyclersexchange.com/
[13] http://www.cooksmill.net/clients.html
[14] http://www.textilefiberspace.com/
[15] http://www.t2e.co.uk/recovered-paper.html

Recyclables Exchange (CBOT) Recyclables Exchange which is described within the main report.

3.3 Exchange-Traded Futures Markets

3.3.1 SRM Futures Markets

A summary of the specific futures markets reviewed for each material is provided in Table 1. It is clear that futures markets for SRMs have remained largely undeveloped among registered trading exchanges, particularly in the market for post-consumer recyclables. Although secondary material futures contracts are currently traded in steel and aluminium, the material specifications in these contracts do not include cans, the main secondary material derived from municipal contracts for door-to-door collections.

Table 1: SRM/ Finished Product Futures Markets Reviewed

Material	Futures Markets for SRM		Futures Markets for Finished Products	
	Year	Exchange (Contract Grade)	Year	Exchange (Contract Grade)
Aluminium	1992 - Present	London Metal Ex. (Al. Alloy/ NASAAC)	1978- Present	London Metal Ex. (High Grade Primary Al.)
Steel	2012 - Present	New York Mercantile Ex. (HMS 80:20 Ferrous Scrap; U.S. Midwest Bushelling Ferrous Scrap)	1990s	Shanghai Futures Ex. (Rebar)
	2015 - Present	Borsa Istanbul Derivatives Market (HMS 80:20 Ferrous Scrap)	2007 - Present	Dubai Gold & Commodities Ex. (Rebar)
			2008 - Present	London Metal Ex. (Billet)
			2008 - Present	New York Mercantile Ex. (Midwest Hot Rolled Coil)
			2009 - Present	Shanghai Futures Ex. (Rebar)
			2013 - Present	National Commodity & Derivatives Ex. (Long/ Commercial)

Material	Futures Markets for SRM		Futures Markets for Finished Products	
	Year	Exchange (Contract Grade)	Year	Exchange (Contract Grade)
Plastic	-	None found	2005-'10	London Metal Ex. (PP, LLDPE)
			2007 - Present	Dailan Commodity Ex. (LLDPE, PP)
			2008 - Present	New York Mercantile Ex. (HDPE, LLDPE, PP, PGP)
			2014 - Present	Intercontinental Commodities Ex. (PGP)
			2014 - Present	Dubai Gold & Commodities Ex. (PP)
Paper/Card	2015 (?)	NOREXECO	1980s	Montreal Exchange
	2000s	Hanover Exchange	1990s	Merrill Lynch
			1995-'11	Chicago Mercantile Exchange
			1996-98	Finnish Options Exchange
			1997-'03	Pulpex
			2005-'08	New York Board of Trade/ Intercontinental Commodities Ex.
			2007- '12	Chicago Mercantile Exchange
Glass	-	None found	2012-Present	Zhengzhou Commodity Ex. (Flat Glass)
Textiles	-	None found	-	Not found

Source: Eunomia Research & Consulting Ltd.

Key points to be noted with respect to currently traded scrap futures contracts in each material are:

1) The recent launch of steel scrap futures by the Chicago Mercantile Exchange (CME) through NYMEX in 2012, and by Borsa Istanbul Derivatives Exchange (VIOP) earlier this year, were both motivated by high price volatility and the volumes of steel scrap traded in the U.S.

and Turkey. The former is currently the largest exporter, and the latter, the largest importer, of steel scrap in the world, implying high exposure to global market fluctuations and resultant price risk.

2) While the LME's primary aluminium contract has been highly successful, both aluminium contracts pertaining to secondary materials (aluminium alloy contracts and North American Special Aluminium Alloy Contracts [NASAAC]) have, as yet, failed to attract significant, sustained trading volumes, intermittently suffering from illiquidity and price crashes. The NASAAC prices have additionally seen divergence of the LME price from the delivery price, resulting in members being forced to use alternative indices as contractual references, and losing out on the hedging opportunities offered by the LME contract.

3) NOREXECO is set up to become the first regulated exchange to trade forestry and paper derivatives, including recovered materials. The launch of the exchange, which will initially trade two pulp and two recovered paper contracts (OCC, ONC), was initially scheduled for Q4 2014, and later moved to Q2 2015. The exchange will use FOEX price indices for settlement.

3.3.2 Finished Products Futures Markets

A study of factors contributing to the success or failure of futures contracts in finished products revealed several interesting findings applicable to potential SRM futures markets. These are summarised below:

Ferrous/ Non-Ferrous Metals

With the expansion of steel markets in Eastern Europe, Asia and the Middle East over the last decade, volumes of steel demanded and supplied globally have increased, as has the level of price volatility associated with materials. Industry players who previously valued long-term contracts in established European and North American markets experienced losses when faced with increased volatility driven by global demand and supply trends.

Trading in an increasingly global market, in which close buyer-supplier relations are no longer desirous, under conditions of high price volatility and price risk, industry actors are being forced to turn to futures trading as both a source of transparent price information, and a hedging mechanism. A similar story underlies the apparent success of LME's aluminium contract, which accurately gauged the potential for aluminium futures at a time when Eastern European markets were expanding.

Plastic/ Polymers

Along with the steel market, the market for polymers has expanded globally over the last decade. The first attempt to establish futures contracts for primary polymers was made by the London Metal Exchange in 2005, though they were delisted by the end of 2011. Despite a series of contract modifications in the interim, a lack of liquidity was eventually cited as the reason for the contract's failure.

Since that time, successful futures contracts have been developed for a variety of grades of primary polymers, with the first real breakthrough being made by the CME Group NYMEX contracts. The CME attributes their success to the integration of upward and downward supply chain products into markets.[16]

Paper/ Pulp

The potential of the primary paper/pulp market for futures trading has been well researched, with no significant successes being identified from a study of the literature. Reports examining the issues associated with the failure of these attempts repeatedly find that quality/ grade specifications, lack of understanding of trading mechanisms, insufficient price risk/ hedging demand and overall industry reticence have been the main causes.[17, 18]

[16] Hall, K. (2013) Plastics Futures Complete the Supply Chain, Now Fed by the Shale Frenzy, *PetroChem Wire*
[17] Till, Hilary; EDHEC-Risk Institute (2014) *Why Haven't Pulp Futures Contracts Succeeded? A Case Study*, December 2014
[18] WRAP (2007) *Managing Risks in the Recovered Fibre Market*, June 2007

3.4 Synthesis of Findings

Registered trading exchanges appear to have only recently begun to explore the potential of SRM futures markets. This can be attributed to the fact that in many markets, the share of recycled materials in manufacturing has increased in recent years. Simultaneously, larger volumes of secondary materials are being collected and globally traded, with higher material demand being driven by legislation and economic expansion in the Middle East and Asia.

Given the current context of the UK market for SRMs, and the review of past and current attempts to establish commodity futures markets (for both primary and secondary materials), the following points are noted:

1) What conditions usually precede attempts to develop commodity futures markets? To what extent do the SRM markets meet these preconditions?

   Conditions that usually precede attempts to establish futures markets include:

   a. Price volatility;

   b. Increasing, and globally traded, volumes;

   c. Global competitiveness (from the perspective of relevant domestic markets); and

   d. Market maturity (vis-a-vis well established trading rules, sufficient balance between hedgers and speculators etc.).

2) What has been the longevity of attempts to develop commodity futures markets?

   Firstly, such attempts have usually involved considerable time investment to complete industry consultations, develop suitable methodologies for the establishment of contracts and ensure a favourable economic climate prior to launching the relevant futures market. The Dubai Gold and Commodities Exchange's polymer contracts, for example, were first scheduled to launch in 2007, but

were subsequently delayed several times until their eventual launch in 2014, due to poor economic conditions.

In addition to this, newly launched futures contracts usually undergo a set of modifications as deemed necessary once trading proceeds. After this point, the markets reviewed have taken from as little as 3 to 6 months, to as much as 12 years (as was the case for the LME primary aluminium contracts) to attract significant industry interest and liquidity. In the majority of instances, poorly-functioning contracts were delisted 3 to 6 years following the launch (e.g. LME plastics futures contracts introduced in 2005 were eventually delisted in 2011 due to insufficient trading volumes).

3) What are the key barriers preventing success of past attempts to establish futures markets for SRMs? How relevant are they likely to be in the present context?

The failure of attempts to develop futures contracts has usually been attributed to a lack of traded volumes on the exchange, invariably linked to illiquidity in the market. The key issues that are potentially at the root of these failures, and have been of particular relevance to the SRM market are:

a. Lack of familiarity with internet trading (for participants) and technical difficulties associated with running an online interface (for exchanges);

b. Insufficient interest in hedging on a futures market rather than modification of existing contractual agreements (or forward contracts);

c. Poor futures contract design, including:

   i. Inadequate delivery mechanisms;

   ii. A lack of industry accepted quality specifications/ grades of materials being traded; and

iii. Inadequate price settlement mechanisms (i.e. reliable spot/cash markets).

d. A high level of Industry reticence – in all cases resulting in insufficient liquidity. This may include factors such as:

i. Lack of familiarity with futures trading and hedging strategy;

ii. Lack of desire for price transparency (this is linked to a contradictory desire for both revenue stability, and simultaneous opportunities for some parties to make windfall profits arising from price risk);

iii. Difficulty in breaking established trade habits, particularly the maintenance of personal relationships between sellers and buyers to ensure quality and security of supply;

iv. Suspicion of futures trading, and particularly the impact of speculative trading on prices (note that China's original steel rebar contracts failed because of excessive speculation); and

v. A 'wait and watch' strategy in which participants hesitate to 'make the first move'. Invariably this results in hedgers being unable to find sufficient speculators, or vice versa, eventually leading to the failure of the contract to attract liquidity.

Table 2 summarises those of the above listed issues that are likely to be of relevance to the present UK SRM markets considered in this study, indicating where the issue has largely been addressed.

Table 2: Past Barriers to Establishment of UK SRM Futures Markets (✓ indicates largely addressed)

Issue	Paper/ Card	Plastics	Aluminium	Steel	Glass
Lack of Familiarity/ Difficulties Associated with Online Trading	✓	✓	✓	✓	✓
Insufficient Interest in Hedging Using Long-term Contracts	x	x	✓	✓	x
Poor Contract Design (particularly access to reliable cash/spot market prices)	x	x	✓	✓	x
Potential level of market activity / liquidity	✓	✓	✓	✓	x

Source: Eunomia Research & Consulting Ltd.

It could be argued that a lack of familiarity with online trading hedging have already been overcome for the futures markets we are concerned with here.

As for the example issue related to the specifications for futures contract design identified above, if the traders realise that the fundamental aim of futures trading is to trade in 'positions' rather than in the physical material, then most traders would be looking to close out positions before they led to either physical delivery of the material concerned. To the extent that one accepts this, then the specification of the contract for which futures were being traded could be quite carefully specified, but would need to be capable of being delivered (in other words, the quality could not be 'unreasonably high') in the event that traders were unable to, or did not want to, close out their positions. There would also need to be warehoused stocks of material which fulfilled this specification to allow for the eventuality that positions were not closed out. The value of this contract would be expected to be sufficiently close to the bulk of SRM being physically traded.

This said, the existence of sufficient liquidity in the market, remains the key hurdle. It is difficult to anticipate at any given time whether this hurdle can be overcome since it is effectively an empirical matter: in principle, there is more SRM being traded than ever before, and so the question arises as to whether

buyers and sellers would see the merit in such a market. In the circumstances we are considering, the interests of the authority and the contractor are not dissimilar in relation to futures markets: they are both sellers, and are looking for 'forward sight' of the value of the SRMs they are collecting and sorting from households (and businesses). The question is therefore whether such a market would attract 'buyers' or speculators for the local authority and contractor positions in sufficient volume for it to function.

There would of course be transaction costs incurred in engaging in such markets. Furthermore, evidence from more mature markets (such as oil) suggests that the risk premium on hedging further out in time is likely to be higher than the premium for shorter maturity periods.[19] The same study notes that the total open interest position in the main futures markets for oil represent around 30 days of oil production, the figure being similar for other commodities. Whilst this might understate the extent of hedging overall (since it does not account for Over the Counter (OTC) transactions), it does include the activity of speculators, thought to account for around 30% of all open interest positions. The suggestion is that even in mature markets, hedging is not undertaken as widely as might be expected.

Hence, although there are good reasons to believe that the interest in markets for SRMs is growing, the level of interest in the market to ensure the viability of the market could not be guaranteed. Equally, it remains the case that perhaps the only way to discover whether this is, or is not, the case may be to conduct empirical 'experiments' in establishing such markets. After all, it seems clear that there are likely to be some actors in all countries who are potential actors in SRM futures whilst the interest in hedging on primary material prices is much more concentrated in some countries than in others (reflecting resource endowments).

[19] See E Borensztein, O. Jeanne and D. Sandri (2009) *Macro hedging for commodity exporters*, IMF Working Paper WP/09/229.

4.0 Assessment of Hedging Potential

Given that futures markets for SRMs are not well developed, an attempt was made to understand the potential for using surrogate markets as means for hedging on SRM prices. We have, therefore, investigated the movements of SRM prices and compared them with the prices of:

1) primary materials; and

2) '(re)processed output', or 'finished product'.

The aim here is to consider whether existing futures markets for some of these materials offer a potentially meaningful route for dealing with price fluctuations because of the closeness of the correlation with key traded positions.

4.1 Selection of Raw / Primary Materials and Finished Products

We have selected the raw / primary materials on the basis of the production process for the SRMs considered in the study. The finished products, on the other hand, are selected based on the end use of the SRMs as inputs for production of new materials. Since raw materials are used as inputs for producing the relevant primary materials (e.g. bauxite is the main input in production of aluminium), we might expect a reasonably strong correlation between the prices of primary materials and SRMs if the main competing material for the SRM is the primary category of the same material. On the other hand, the SRMs can act as substitutes for finished products or as feedstock in production of the final output (e.g. recycled aluminium can substitute for primary aluminium in beverage can production), thus their prices should be expected to display a high degree of correlation.

Finally we have narrowed down this selection of the primary materials and finished products based on the existence of futures market for these materials. Table 3 lists the SRMs considered in the study along with corresponding primary materials and finished products selected for price movement comparison.

Table 3: Primary Materials and Finished Products Considered for Comparison

SRM		Primary		Finished Product
Material	**Product**	**Material 1**	**Material 2**	
Aluminium	Cans	Bauxite	Energy	Primary Aluminium
Steel	Cans	Iron Ore	Energy	Primary Steel
Plastics	HDPE Natural	Ethylene	Petroleum	Virgin HDPE
	Clear PET	Ethylene glycol	Petroleum	Virgin PET
	Coloured PET	Ethylene glycol	Petroleum	Virgin PET
Paper	News & Pams	Soft Logs	Hard Logs	Wood Pulp
	Mixed Paper & Card	Soft Logs	Hard Logs	Wood Pulp
Glass	Clear	Silica Sand	Energy	Container Glass or Soda-lime glass
	Amber	Silica Sand	Energy	Container Glass or Soda-lime glass
	Green	Silica Sand	Energy	Container Glass or Soda-lime glass
	Mixed	Silica Sand	Energy	Container Glass or Soda-lime glass

Source: Eunomia Research and Consulting Ltd

4.2 Correlations

If one was to use an existing commodity futures market to hedge against the price fluctuations in SRMs effectively, the price of the underlying SRM would need to be closely correlated with the price of the commodity traded in the futures market. We have, therefore, calculated the correlations of the prices of the SRMs considered in this study with the prices of primary materials and finished products listed in Table 4.1. Points to note regarding the data used are discussed below:

- We have used SRM price data reported by LetsRecycle (with the exception of steel and aluminium cans for which WRAP MPR price data were used); this source was used since it contains a higher number of data points compared to some other publically available sources.[20, 21] These data are denominated in UK sterling;

[20] http://www.letsrecycle.com/prices/
[21] http://www.wrap.org.uk/content/materials-pricing-report

- The data used for primary materials prices were the monthly commodity prices data published by the World Bank (WB) and the International Monetary Fund (IMF).[22, 23] The monthly prices for Virgin HDPE and Virgin PET were provided by WRAP from Plastic Information Europe (PIE).[24]
- Primary price data from the WB and IMF are in dollars, and virgin plastics data from PIE are in Euros. Conversion to Sterling was achieved using Bank of England monthly average exchange rate data.

The correlations between SRM prices and the prices of related primary material and finished products are reported in Table 4. The correlation estimates higher than 0.8 are presented with bold text in the table, while the negative correlations are denoted by red coloured text.

[22] http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,,contentMDK:21574907~menuPK:7859231~pagePK:64165401~piPK:64165026~theSitePK:476883,00.html
[23] http://www.imf.org/external/np/res/commod/index.aspx
[24] http://pieweb.plasteurope.com/default.aspx?pageid=2000

Table 4: Correlations between SRM Prices, and Related Primary Materials and Finished Products

SRM	Primary Materials / Finished Products (Correlations)			
Aluminium Cans	Primary Aluminium (0.6441)	Primary Copper (0.4399)	Crude Petroleum (0.3205)	
Steel Cans	Primary Steel (0.7355)	Primary Tin (0.7889)	**Primary Copper (0.8052)**	Iron Ore (0.7682)
HDPE Natural[25]	**Virgin HDPE (0.8929)**	**Crude Petroleum (0.8804)**		
Clear PET[26]	**Virgin PET (0.9394)**	**Crude Petroleum (0.8691)**		
News & Pams	**Wood Pulp (0.8698)**	**Hard Logs (0.8487)**		
Mixed Paper/Card	**Wood Pulp (0.8127)**	Hard Logs (0.7697)		
Glass (Clear)	Natural Gas (0.4740)			
Glass (Amber)	Natural Gas (0.3834)			
Glass (Green)	Natural Gas (0.1628)			
Glass (Mixed)	Natural Gas (-0.1612)			

Source: Eunomia Research and Consulting Ltd

The variation in, and lack of strength of, some of the correlations in Table 4.2 may be explained by the fact that for many markets, the 'secondary material' does not compete solely, or as a perfect substitute, with the primary material or the finished product. The main findings from the correlation analysis are highlighted below:

- Both Clear PET and Natural HDPE show high correlation with crude petroleum as well as their virgin substitutes.
- Both types of secondary paper (News & Pams and Mixed Paper & Card) show high correlations with the corresponding finished

[25] Defined as 'HDPE – High Density Polyethylene – detergent bottles, milk jugs' http://www.letsrecycle.com/prices/

[26] Prices for Clear and Light Blue PET used. Defined as 'PET – Polyethylene Terephalate – soft drinks bottles, water bottles' http://www.letsrecycle.com/prices/

product, wood pulp. News & Pams also have a high correlation with the related primary material, hard logs (timber).

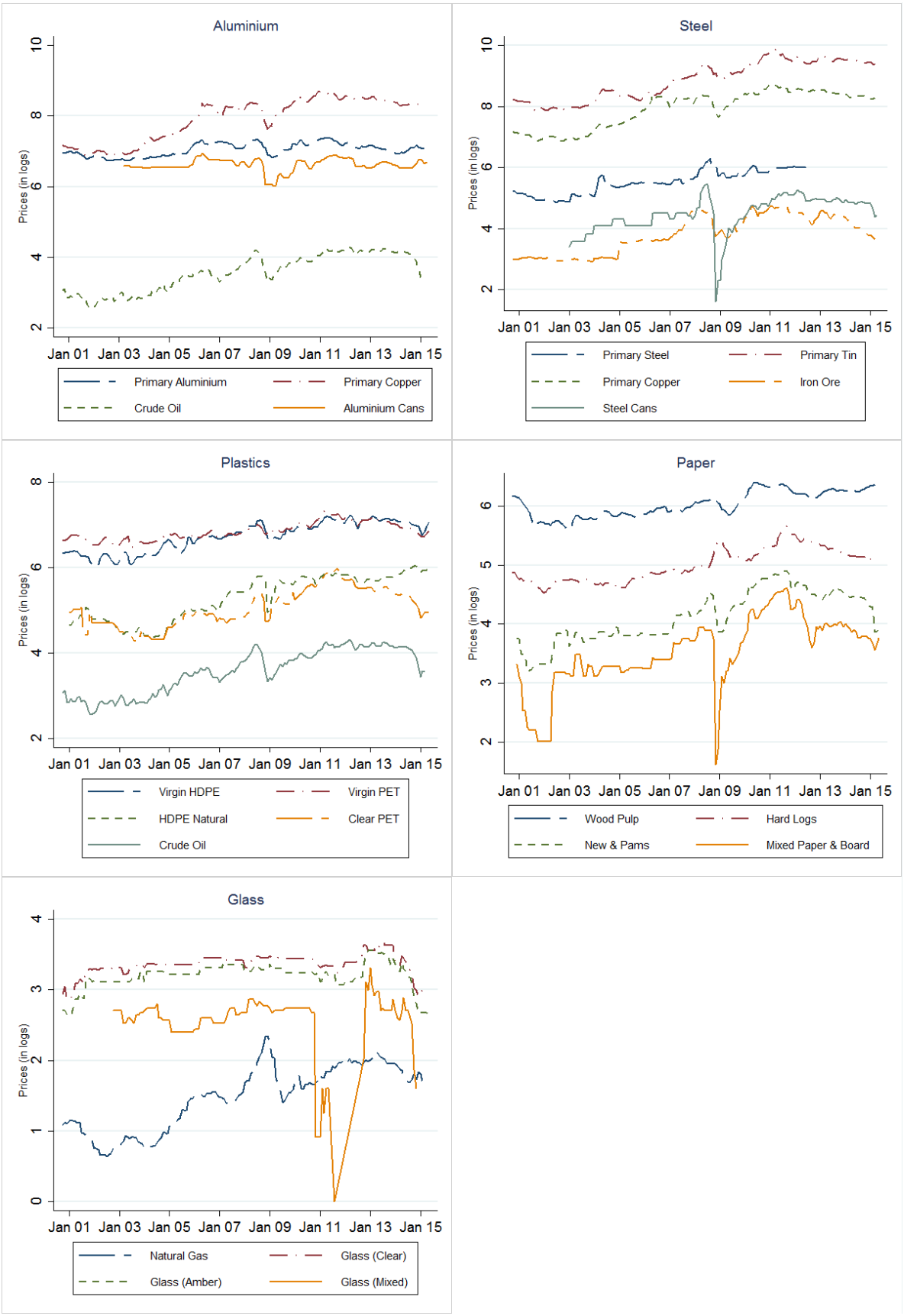
- Steel shows better correlation with an apparently unrelated finished product (primary copper) as compared to related primary material (iron ore) and finished product (steel rebar).
- All three types of textile prices show very high correlation with one of their related primary material, wool. However correlations with the other primary material, cotton, are relatively low.

These correlations tell us something about the extent to which price movements are similar, but they do not tell us what the strength of correlation would need to be to justify using the surrogate market as a reliable hedge.

4.3 Price Movements

The correlation between the SRM prices and the prices of primary materials/finished products only captures the extent of linear relationship between them. We also therefore need to look at the movements in prices of these materials to effectively use the existing futures markets as a hedging platform for the SRMs. Figure 1 depicts the historical price movements for the SRMs and related primary materials / finished products using the data described in Section 4.2.

Figure 1: Price Movements for SRMs and related Primary Materials and Finished Products



Source: Eunomia Research & Consulting Ltd

Figure 1 reveals that some of the SRM prices display movements which are broadly similar to the price movements of the related primary materials and finished products. However, to use the futures market for a primary material / finished product as a hedging platform for a particular SRM, the price of the SRM needs to closely mimic the price movements for that primary material / finished product, which is not the case for any of the SRMs considered in the study. Some of the irregularities displayed in the price movements are highlighted below:

- The price of steel cans displays a significant drop during the end of 2008 and beginning of 2009. One of the reasons for that could be reduction of secondary steel usage in steel production by some of the large steel producers.
- We can also observe a similar trend for mixed paper and card, prices for which also fell sharply during that period. However, mixed paper and board prices have displayed another significant drop between early 2001 and mid-2002.
- Secondary PET and HDPE prices moved in a similar direction to crude petroleum until 2012. Thereafter, secondary HDPE prices started moving in the opposite direction to those of petroleum, secondary PET, and virgin HDPE.
- The price movements for secondary glass products could not be compared with a related primary material (silica sand) or a related finished product (container glass, or soda-lime glass), due to lack of data availability. Instead, we compared the secondary glass prices with the price of natural gas (which is the main energy input in production of glass). However, the correlation was weak.
- The price of mixed glass fell sharply in the end of 2010, and continued to fall until 2012. After that, in 2013, it rose above its previous level, and came back sharply by the end of 2014. This could be due to the separation of targets for glass-remelt recycling from aggregate glass recycling under the producer responsibility system for packaging in the 2013 PRN compliance year. SRM prices for glass

are relatively strongly influenced by PRN/PERN prices, and these appear to be even more volatile than prices for SRMs.

4.4 Hedging with Recyclate Blended Price

Contracts for dry recyclables do not lead to the collection of a single material, but typically, a range of materials is collected. We also explored the possibility of hedging the SRM price risks using a 'recyclate blended price' representing the unit price of a typical tonne of dry recyclate. Materials prices were taken from Letsrecycle and weighted using an estimate of the composition of kerbside collected domestic recycling for our target materials (Table 5) developed by Eunomia.[27] There are clear limitations with this approach, including but not limited to the fact that it does not take into account the changing composition of recycling over time. The intention here is, however, to investigate the possibility of using a recyclate blended price as the basis for hedging against future price fluctuation.

Table 5: Weights for Constructing Recyclates Blended Price

Material	Index Weight
News & PAMS	42%
Mixed Paper and Card	18%
Plastic Films	4%
HDPE Natural	1%
PET Clear	2%
Aluminium Cans	1%
Steel Cans	4%
Glass	*29%*

Source: Eunomia Research & Consulting

For analysing the hedging potential using the recyclate blended price, we have calculated correlations with different primary materials, finished products and other macroeconomic price indices. Table 6 reports some of the materials that are highly correlated with the recyclate blended price. Iron-ore, copper, tin, wood pulp and petroleum displayed the highest correlations. The majority of

[27] http://www.letsrecycle.com/prices/

the price indices analysed were found to be highly correlated with the recyclate blended price.

Table 6: Correlation of Selected Materials and Indices with Recyclate Blended Price

Commodity	Correlation
Iron Ore	0.8972
Copper	0.8985
Tin	0.9039
Wood Pulp	0.8571
Crude Oil	0.8811
All Commodity Index	0.8789
All Commodity Index (excl. Oil)	0.9205
Agricultural Raw Materials Index	0.8729
Metals Index	0.8758
Industrial Input Index	0.9064

Source: Eunomia Research & Consulting Ltd

We also analysed the price movements of the recyclate blended price with selected materials and indices. This is depicted in Figure 2.

Figure 2: Movements of Recyclate Blended Price and Related Material Prices

Source: Eunomia Research & Consulting Ltd

The bottom panel of Figure 4.2 shows that the movements of all commodity prices (excluding fuel) and the index of industrial input prices are very similar to the recyclate blended price. The reason for this is likely to be that the blended recyclate price index is more likely to reflect general macroeconomic trends, and so, may display price movements similar to macro-level indices. Although this will be somewhat sensitive to the composition of materials used,

fairly substantial shifts in composition are likely to be necessary before the strength of this correlation is strongly affected.

4.5 Conclusion

It seems that although futures markets that would facilitate hedging against (excessive) price movements of SRMs are in the nascent phase of their development (and are absent for some materials), there are attempts to develop these, and these attempts can expect to continue given that many of the barriers to developing futures markets for SRMs would appear to have been overcome.

As an alternative approach, it might be possible to use surrogate markets to hedge on the price of a basket of recyclables. The correlations with key macroeconomic indicators is relatively strong, as is that with the price of crude oil.

There is a more fundamental question, however, regarding how futures markets might be used as a basis for managing price fluctuations over a contract life: materials are being collected and marketed throughout a period of seven or so years. The price premium for any degree of price security for a material over a period seven years in advance is likely to be high. Seeking to use futures markets as a basis for managing price fluctuations for a range of materials is likely to incur even higher transaction costs. One approach to mitigating the impact of this pricing premium may be for the contractor to develop some form of ‘back-to-back’ arrangement with reprocessors who have, themselves, used appropriate hedging mechanisms to secure prices within a specified range. However, this approach is also likely to be complex for the contractor to secure unless and until this becomes the norm in the marketplace.

Consequently, and as noted above, whilst we believe that the main obstacles to establishing futures markets have been overcome, and whilst we believe that the outstanding issue is one of how well the market is used, we have not recommended this as a means of dealing with price risks in the context of local authority contracts.

5.0 Investment Funds

5.1 Use of Investment Funds as an alternative to direct hedging

Direct hedging, involving either individual actors within the supply chain entering into their own individual risk management strategies, or the development of derivatives markets (including forwards, futures, or options contracts) is theoretically the most appealing approach to managing price risk in commodities. In practice, however, the success of these attempts is likely to be impeded by a number of issues, as discussed in the preceding sections.

An alternative approach, and one that has been more common for managing commodity price fluctuations, is for a central body to act to manage risk through the development of investment funds, including price stabilisation funds, savings funds, or a combination of both.

Over the last few years, the total assets under management by such funds has grown considerably, with funds being created and maintained in roughly 30 countries worldwide. These funds are estimated to handle assets worth around $7,162.5 billion, with oil and gas related funds accounting for about $4,191.3 billion of this amount.[28] To put this into context, the size of the UK economy was $2.7 trillion in 2013. Although SWFs tend to vary considerably in their description and purposes, they are generally defined as:

"A special investment fund created or owned by a government to hold assets for long-term purposes; it is typically funded from reserves or other foreign currency sources, including commodity export revenues, and predominantly owns, or has significant ownership of, foreign currency claims on non-residents."[29]

The Sovereign Wealth Fund Institute outlines that SWFs may have their origins in either commodity markets (for which the fund is created through revenues associated with commodity exports), or non-commodity markets (usually

[28] http://www.swfinstitute.org/fund-rankings/

[29] Rossi, M., and Lam, R. (2010) Sovereign Wealth Funds - Investment Strategies and Financial Distress, *Journal of Derivatives and Hedge Funds*, Vol.15, pp.304–322

created through transfers of assets from official foreign exchange reserves). For the purpose of this study, we focus on SWFs originating in commodity markets, which have objectives including:

- Protecting and stabilising the budget and economy from excess volatility in revenues/ exports;
- Diversifying from non-renewable commodity exports;
- Increasing savings for future generations;
- Funding social and economic development; and
- Creating sustainable capital growth and political strategy in target countries.

5.2 Examples

These types of funds are usually grouped under five broad categories based on their objectives and functions. These are stabilisation funds, savings funds, development funds, pension reserve funds and reserve investment funds. For the purpose of managing SRM price risk, we focus on the first two of these i.e.

- Stabilisation funds; which are usually set up to manage risks to the budget from price volatility and external shocks; and
- Savings funds; intended to share wealth across generations by diversifying assets from non-renewable resources into financial assets.[30]

Both of these are typically found in countries that are heavily dependent on commodity exports for their budget / foreign exchange earnings. Investment decisions in these two fund types differ as per their stated objectives. While stabilisation funds have a low level of risk tolerance and short term investment horizon, in line with their goals to minimise expenditure volatility and maximise liquidity, savings funds are typically managed over long-term horizons, with a higher risk profile of investment. It is important to note,

[30] Papaioannou, M., Al-Hassan, A., Skancke, M., and Sung, C.C. (2013) *Sovereign Wealth Funds: Aspects of Governance Structures and Investment Management*, November 2013

however, that these two are not mutually independent of one another, and often have overlapping objectives. Table 7 provides examples of stabilisation funds from around the world, some of which perform the dual function of a savings fund as well.

Table 7: Selected Investment Funds (Fiscal Stabilisation and Savings)

Fund Name	Country	Fiscal Stabilisation	Savings
Fund Soberanu de Angola*	Angola	✓	✓
State Oil Fund	Azerbaijan	✓	✓
Future Generations Reserve Fund	Bahrain	✓	✓
Economic and Social Stabilization Fund	Chile	✓	
Oil Stabilization Fund	Iran	✓	
Kazakhstan National Fund*	Kazakhstan	✓	✓
Kuwait Investment Authority	Kuwait	✓	✓
Mexico Oil Stabilization Fund	Mexico	✓	
Fiscal Stability Fund*	Mongolia	✓	✓
Nigeria Sovereign Investment Authority*	Nigeria	✓	✓
Government Pension Fund-Global	Norway	✓	✓
Papua New Guinea SWF*	Papua New Guinea	✓	
Oil Stabilization Fund	Russia	✓	
Timor-Leste Petroleum Fund	Timor-Leste	✓	✓
Heritage and Stabilization Fund	Trinidad and Tobago	✓	✓
Stabilization Fund	Venezuela	✓	✓

**The fund also includes a social/ development fund objective.*

Source: Adapted from Hassan, A. et al. (2013), Sovereign Wealth Funds: Aspects of Governance Structures and Investment Management, IMF (Monetary and Capital Markets Dept.) Working Paper 13/231, 2013

There are several examples at a nation state level of countries using investment funds to attempt to manage risk where earnings from state-owned commodities are crucial in determining the health of the economy. Among the most famous examples of this are oil-rich countries (such as Mexico) using OTC hedging arrangements to guarantee a fixed income per barrel. Given that the

Mexican government relies on oil revenue for around a third of its federal budget, the stakes in such a strategy are high: the continuation of its hedging programme suggests that such a strategy offers a reasonable insurance against future volatility for this crucial source of earnings. Similarly, the present Chilean Economic and Social Stabilisation Fund (ESSF) as well as its Pension Reserve Fund were funded from surplus revenues in its Copper Stabilisation Fund (created in 1985). The Chilean economy has historically been highly dependent on copper, and though dependence on copper mining has declined over the years, just over half the country's $77 billion worth of exports in 2014 accounted for by copper materials alone.[31] Insulating the economy from trade shocks and volatility in copper exports has been crucial to maximising the assets that this resource delivers.

In India, a price stabilisation fund is currently being created for agricultural commodities (initially to include potatoes and onions), which have been subject to extreme price volatility and speculative activity since 2010.[32] Funds such as this, and similar ones maintained in Kazakhstan, Japan and Korea, usually function through the creation and maintenance of buffer stocks as a form of market intervention by local and central authorities.[33, 34] Governance and sources of initial investment for these funds may vary, but commonly parties contributing to the fund have an equivalent share in the profits to the ratio of their original contributions. The fund is then utilised in the procurement, storage, and maintenance of agricultural commodities from the farmers (usually in the harvest season, when high supply volumes tend to lower prices), as well as the eventual distribution of those stocks when seasonal supply is low (hence preventing unmanageable price spikes during such periods). Additionally, celling and floor price mechanisms may be applied to procurement strategies in order to ensure that farmers' revenue, as well as fund expenditures, is less uncertain.

5.3 Potential Application to SRM Price Risk Management

[31] https://atlas.media.mit.edu/en/profile/country/chl/
[32] Ministry of Agriculture (Government of India) (2015) *Operational Plans for PSF (Price Stabilisation Fund)*, March 2015
[33] OECD (2013) *OECD Review of Agricultural Policies: Kazakhstan 2013*, 2013
[34] OECD (2001) *Agricultural Policies in OECD Countries: Monitoring and Evaluation*, 2001

Clearly any investment fund used to collaboratively help manage SRM price risk in the UK is not necessarily going to have the same objectives as the funds described above. However, the principles underpinning the establishment of such funds – that they allow a relatively stable revenue take, and the build-up of a fund when prices are higher than minimum levels - are potentially applicable to the situation local authorities find themselves in. Two possible approaches are considered in the main report, though additional work is also recommended to explore further the applicability of this option.

For an overarching conclusion to the issues considered in this Technical Appendix, please refer to the main report.

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