Modelling Mining and Oil Projects & Fiscal Regimes

CABRI Dialogue on Extractives

April 2016

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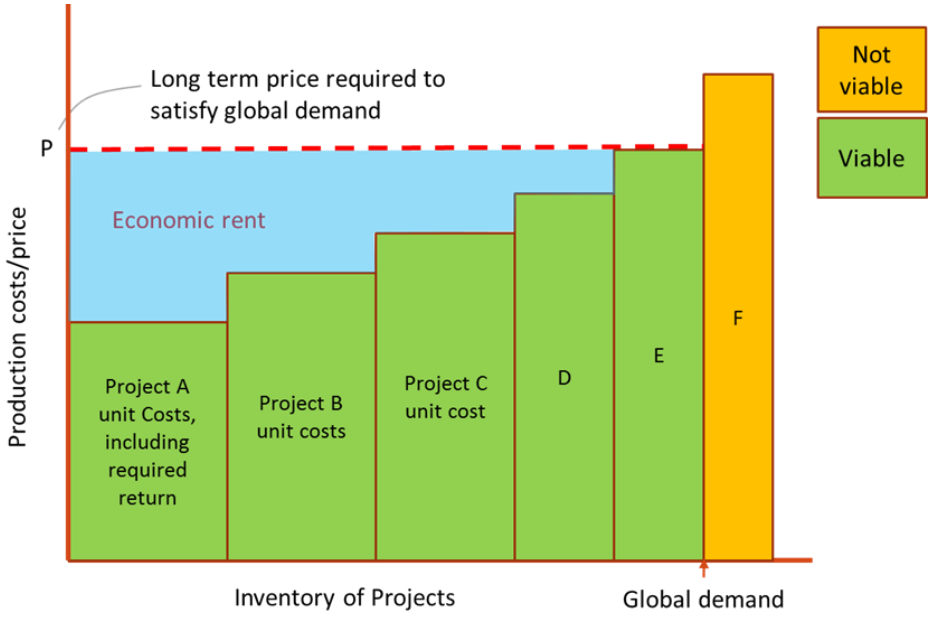
A week's modeling course in 2 hours

1. The background needed to make it all work (rent, life cycle, characteristics)
2. In the market: the impact of cost curves on project revenues
3. The Single Period Model: getting our hands on a model
4. An annualised model: as the investor sees it
5. Some real live models and what they teach us: Tanzania & Mongolia
6. What is needed to embed modeling in public institutions?

Mining, oil & gas Features

- Projects exploit a finite resource
- Long, costly exploration periods
- Significant geological, technical, political, environmental risks
- Large up-front investments
- Sophisticated management and specialized technology
- Prices (mostly) set on international markets; price volatility
- High costs of abandonment
- Significant environmental impact & risks
- High community impact

Economic rent



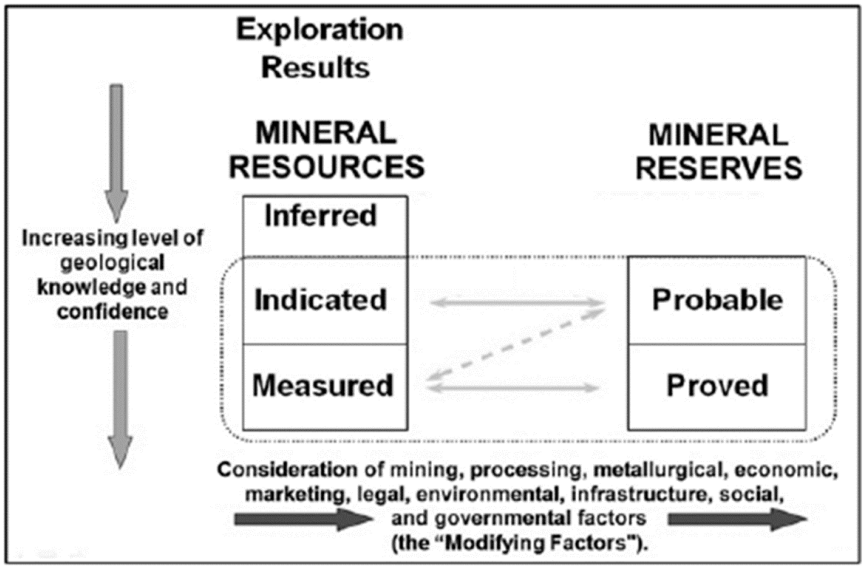
•Deposits vary in size, location & quality. Each therefore has a different production cost
•Investors needs to earn at least the production cost plus an acceptable return on investment
•Prices for most commodities are set on international markets. The price needs to be high enough so that the highest-cost project necessary to meet world demand is made just viable
•But that means lower cost projects will make super profits – this is "Economic Rent": the surplus return above the minimum return necessary to induce the investment
•Economic Rent could (in theory) be captured by the resource owner - not by the extractor – without deterring the investment
•The trouble is, economic rent is (1) Unknown in advance; (2) Uncertain; and (3) Volatile
•Also, to invest in risky exploration investors need to earn enough profit on successful projects to cover failed exploration
•So, "Economic Rent" is a subtle, somewhat subjective concept, but with profound implications for fiscal regime design

Exploration process

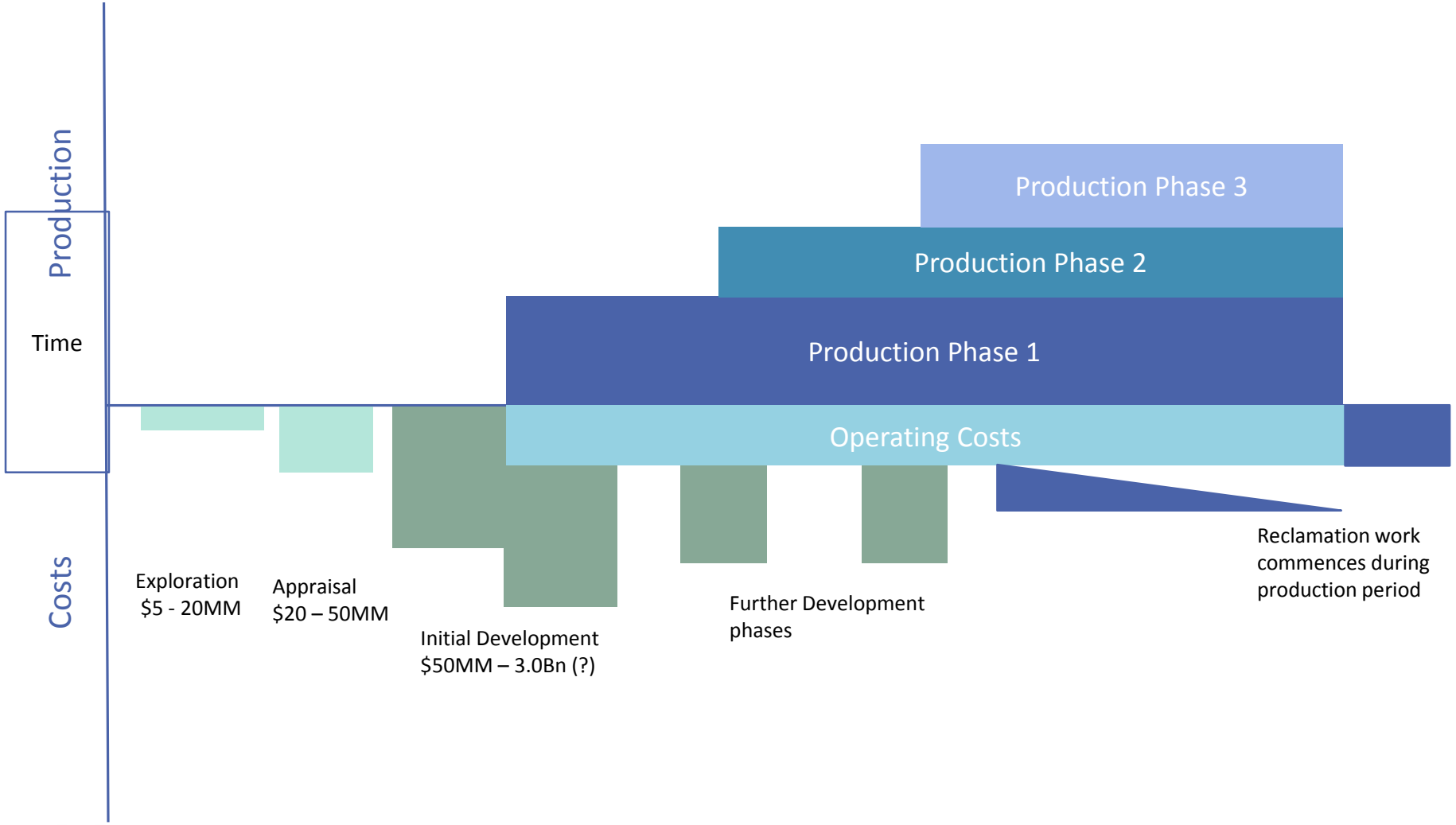
Acquire rights	Initial exploration	Identify targets	Exploration drilling	Appraisal drilling	Feasibility study	Development planning

Remote sensing; regional geochemistry; airborne geophysics; seismic surveys

Feasibility study: Mineral Resources
Development plan: Resources reclassified as Mineral Reserves



Mining project life cycle



(basic) Cost categories

Exploration	Searching for deposits
Appraisal	Delineating the size and characteristics of a discovered deposit: Evaluating technical and economic viability
Development costs	Building the project
Operating costs	Producing the mineral: Fixed versus Variable with production
Overheads	Fixed costs of managing production
Sustaining capital	Replacing equipment periodically. Treated as capital cost for tax purposes
Rehabilitation and Decommissioning	Costs of clean up during and after production

"Capital" versus "Operating" costs:

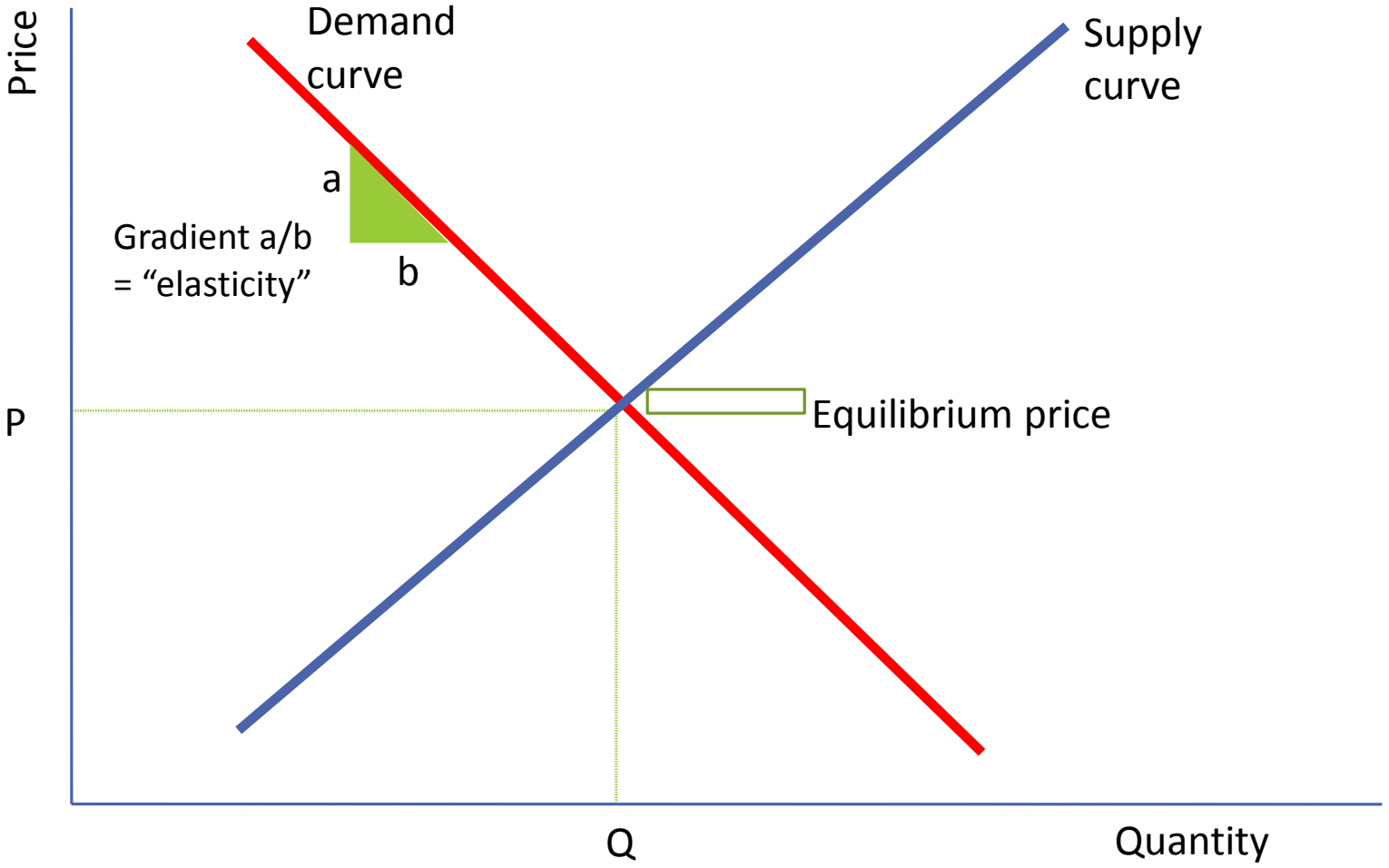
•Capital costs have a benefit beyond a single year, and therefore usually have to be depreciated for tax purposes.

•Operating costs are recurring costs with no lasting benefit, so are expensed immediately for tax

Most economic analysis is done using cashflows where the distinction does not matter, except to calculate tax payments

Capital expenditure often referred to as "Capex". Operating Expenditure as "Opex"

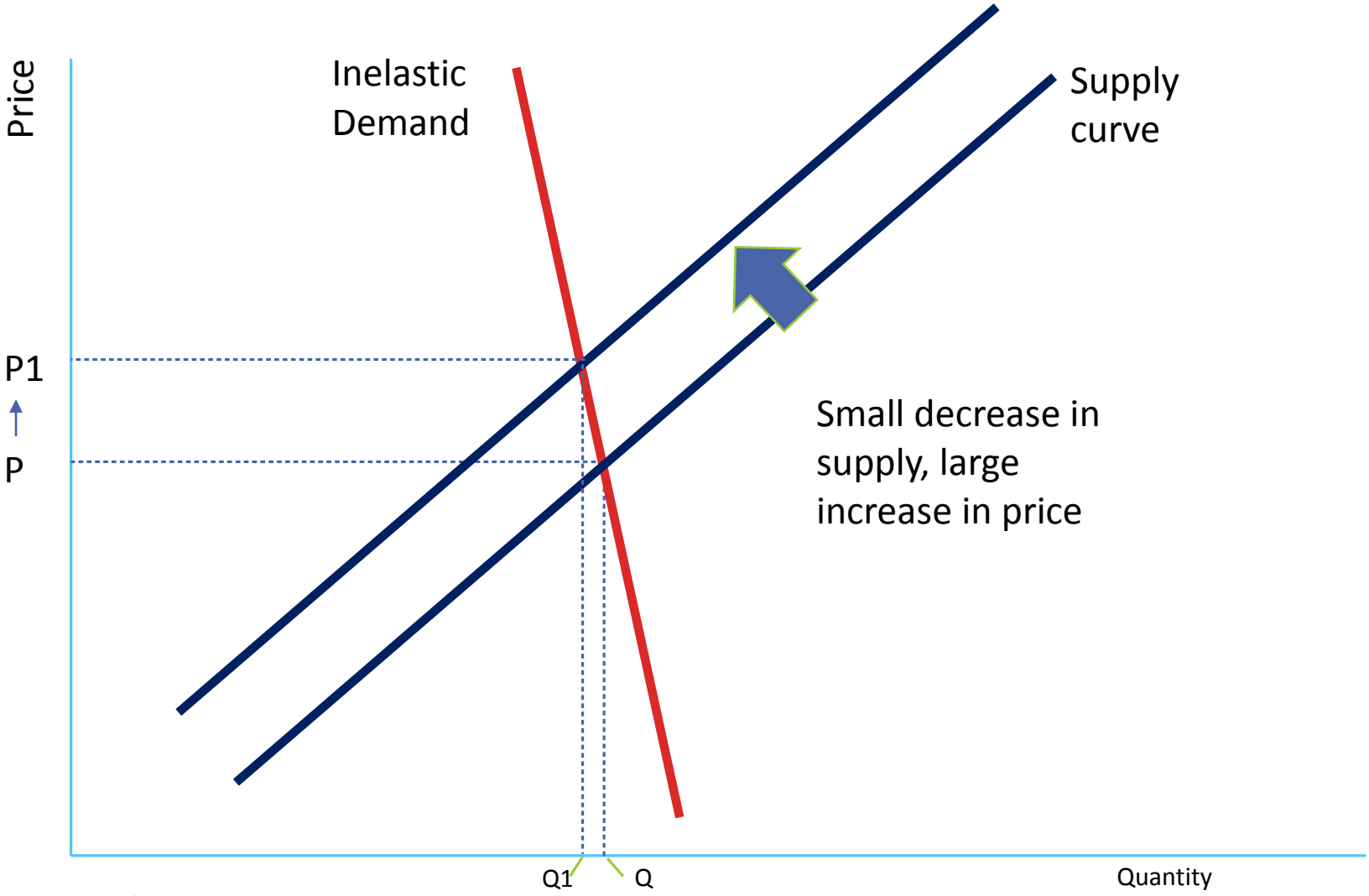
Commodities: supply and demand



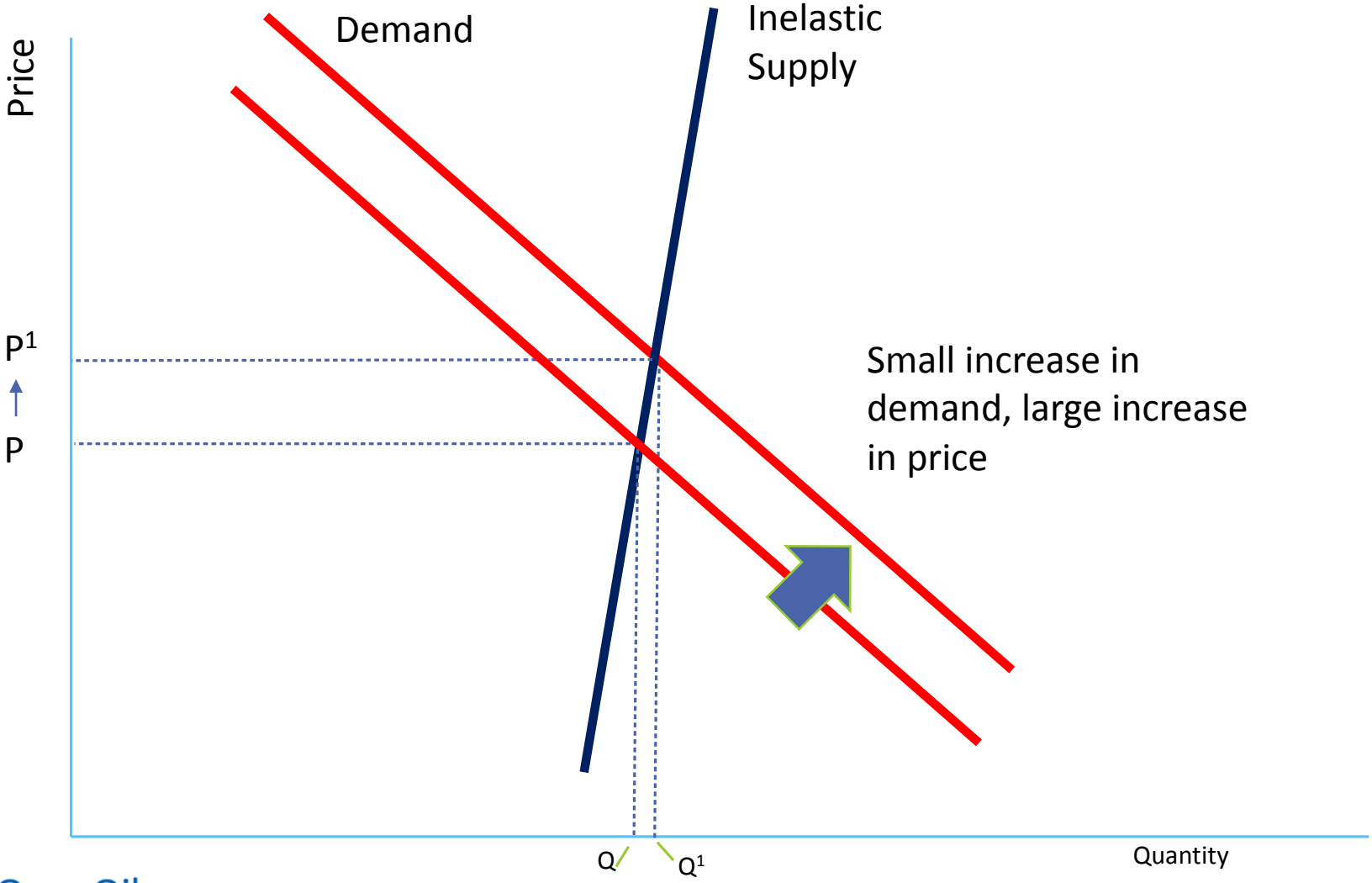
What determines the shape of the Supply and Demand curves

Short Term	•Prices and demand curves for end-use products •Availability & price of substitutes •Cost to switch	•Flexibility in mine production e.g. putting mines on care and maintenance in price slump •Opec (oil)
Long term	•Prices and demand curves for end-use products •Availability & price of substitutes •Cost to switch	•Depletion of existing mines •Geology: unexploited resources and cost to find and extract •Opec Cartel (for oil) •Government policy: e.g. •Access to resources •Fiscal regimes (cost to extract) •Carbon reduction policies •Nuclear power plant usage •Etc.

Inelastic demand



Inelastic supply



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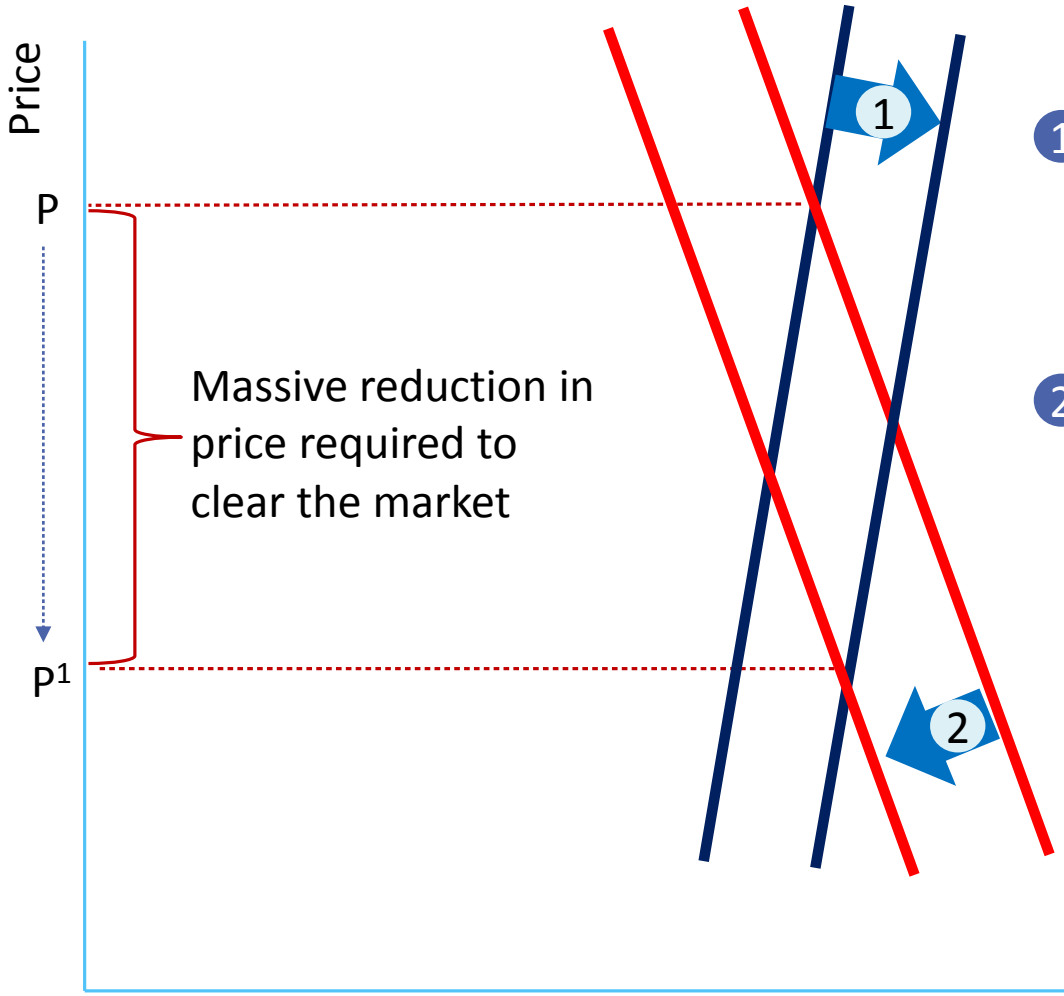
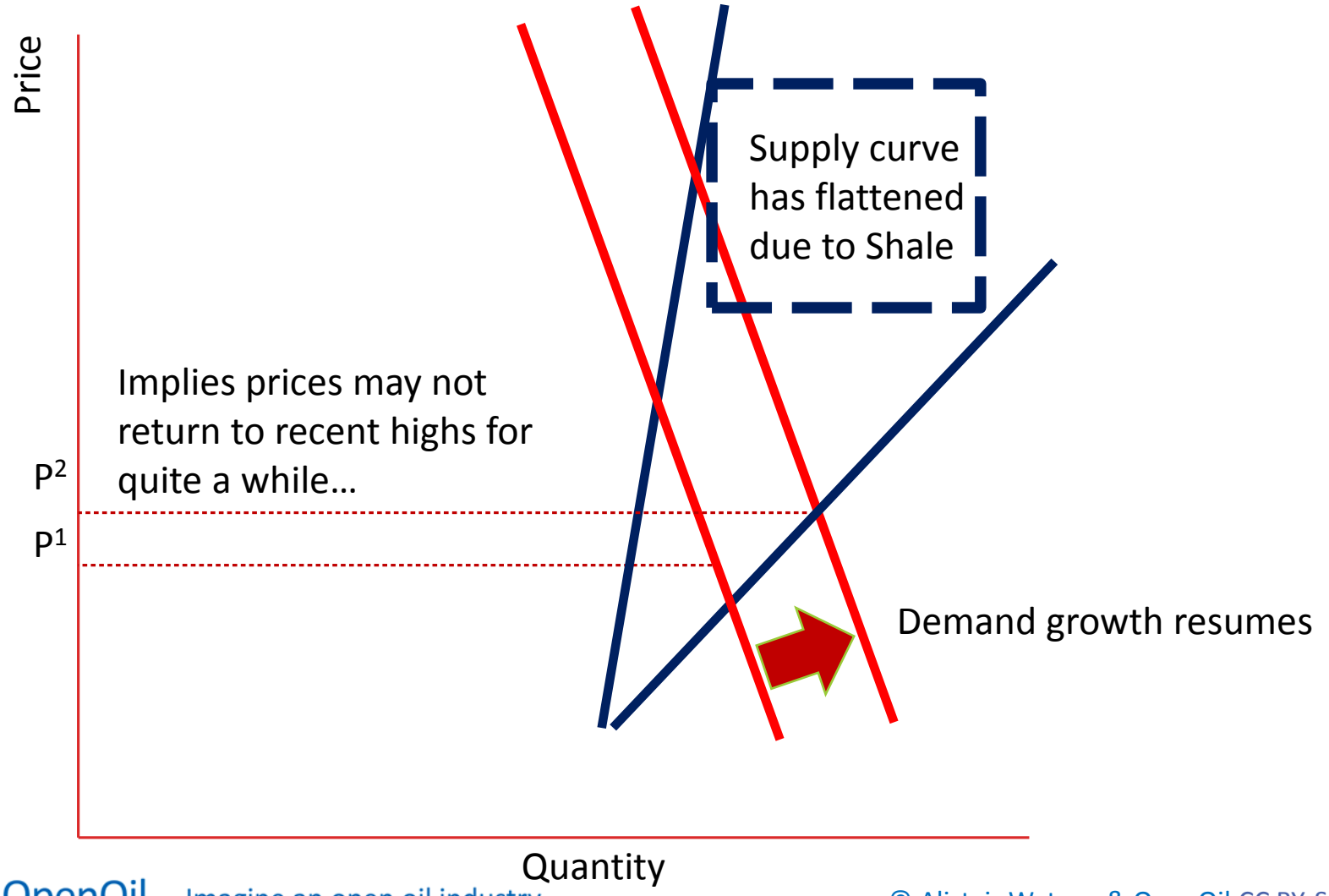
Does this help explain recent oil prices?



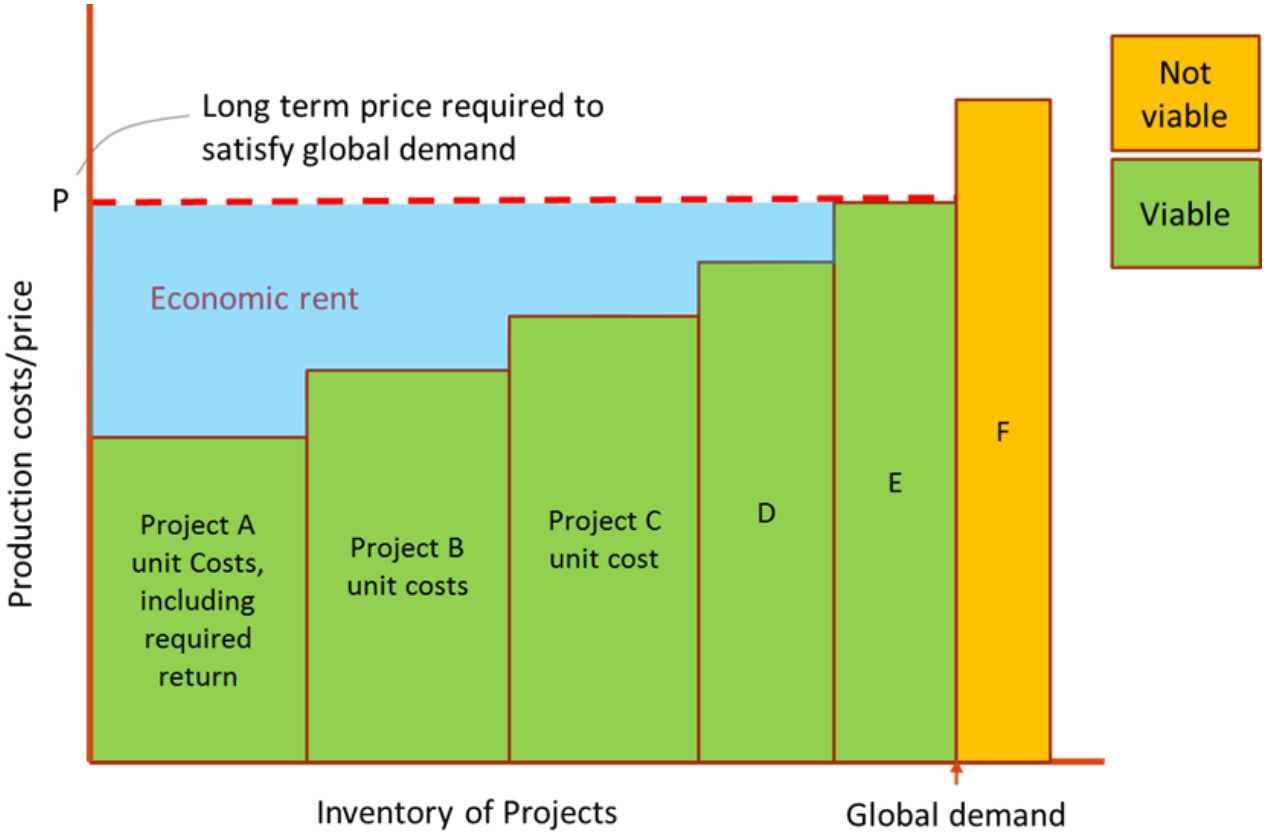
1. Increase in short term supply (US production; growing inventories)

2. Slowing of demand increase from Asian economies

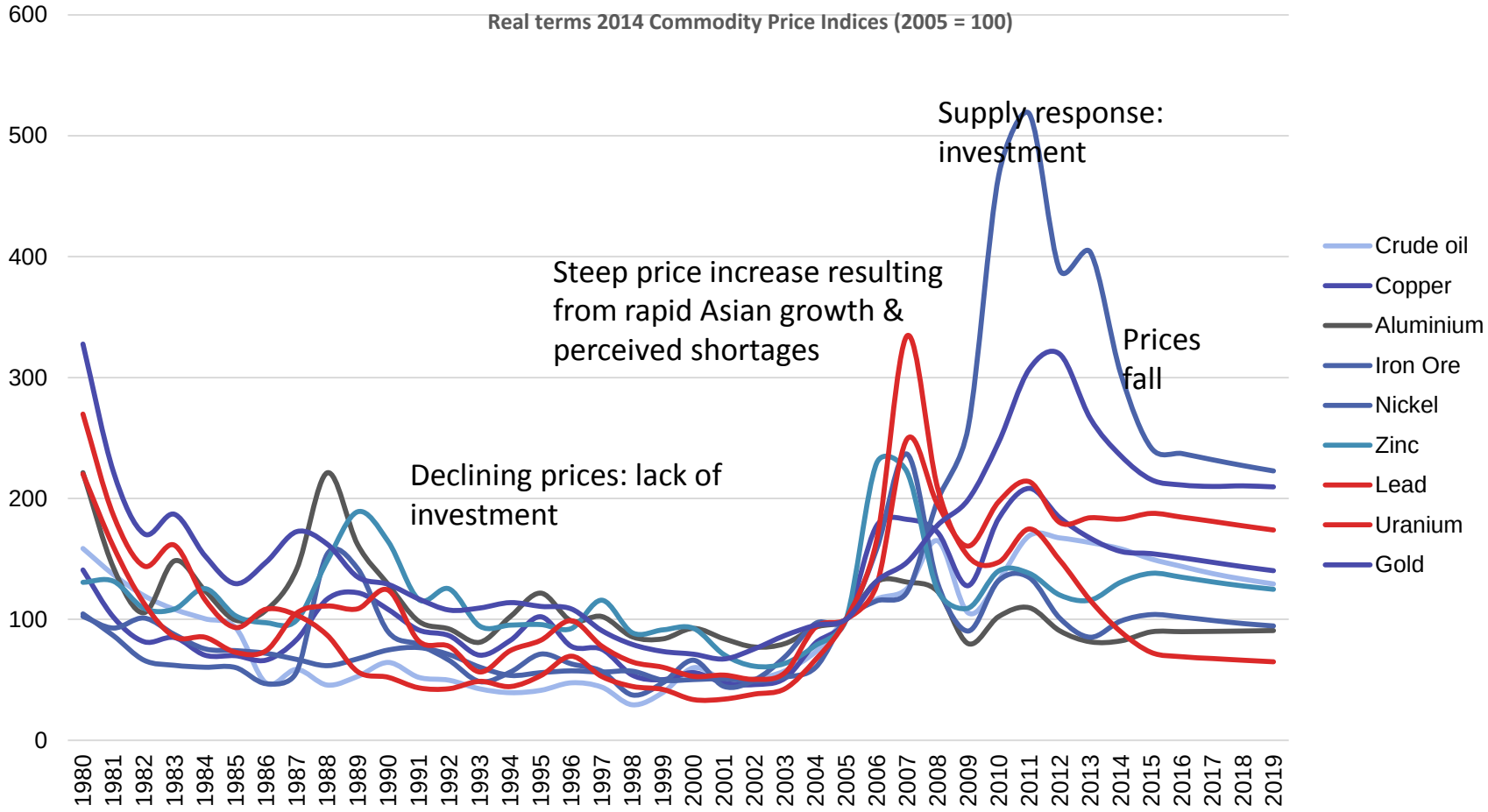
The “Lower for Longer” view on oil



Remember this?



Real-terms 2014 Commodity Prices



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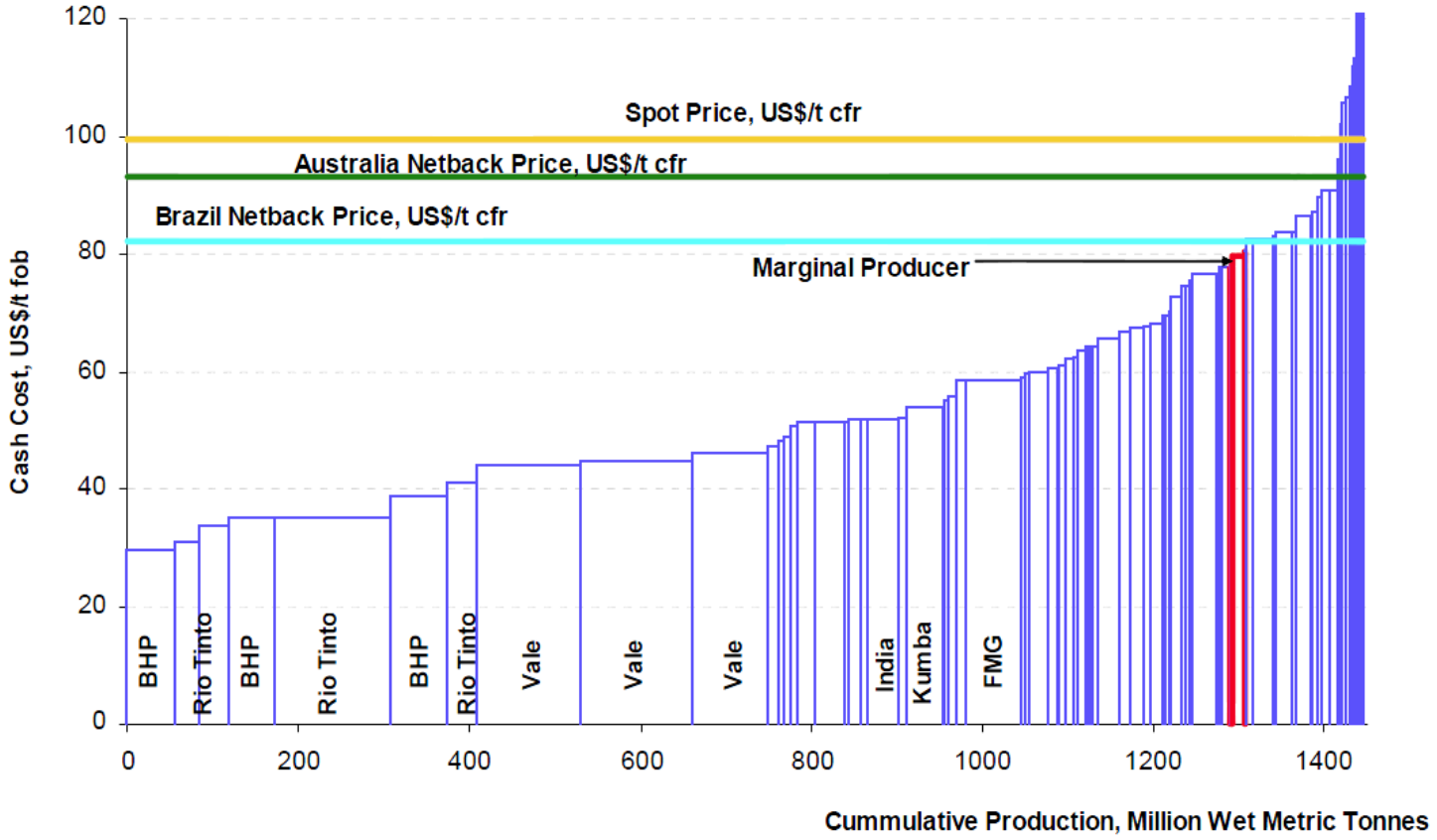
Iron ore cost curve example



Source: CRU Ltd, Morgan Stanley Research

http://www.bing.com/images/search?q=iron+ore+cost+curve&id=AE5391761DC3976D4885155D9B61F418A28B03FC&FORM=IQFRBA#view=detail&id=AE5391761DC3976D4885155D9B61F418A28B03FC&selectedIndex=0

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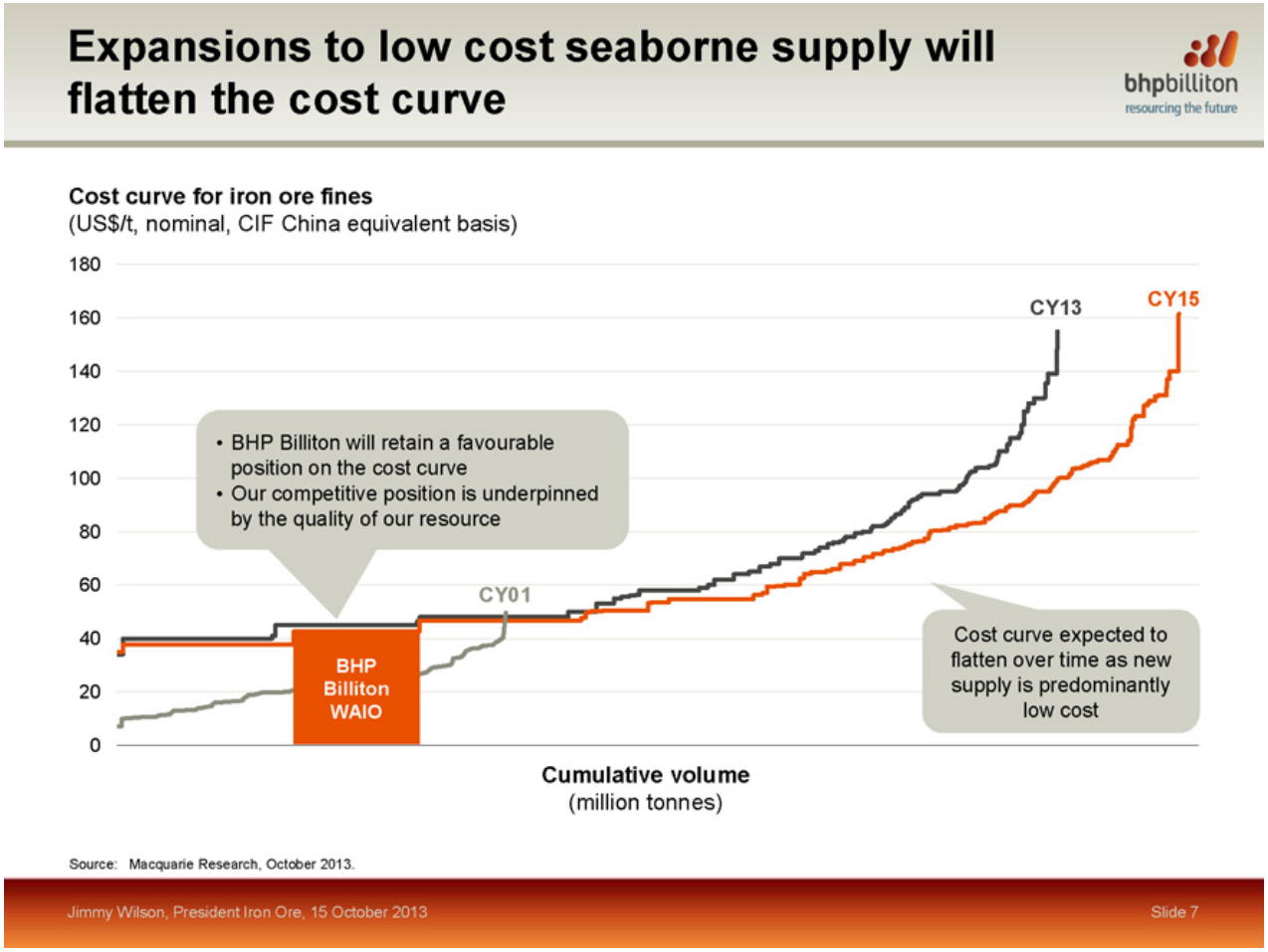
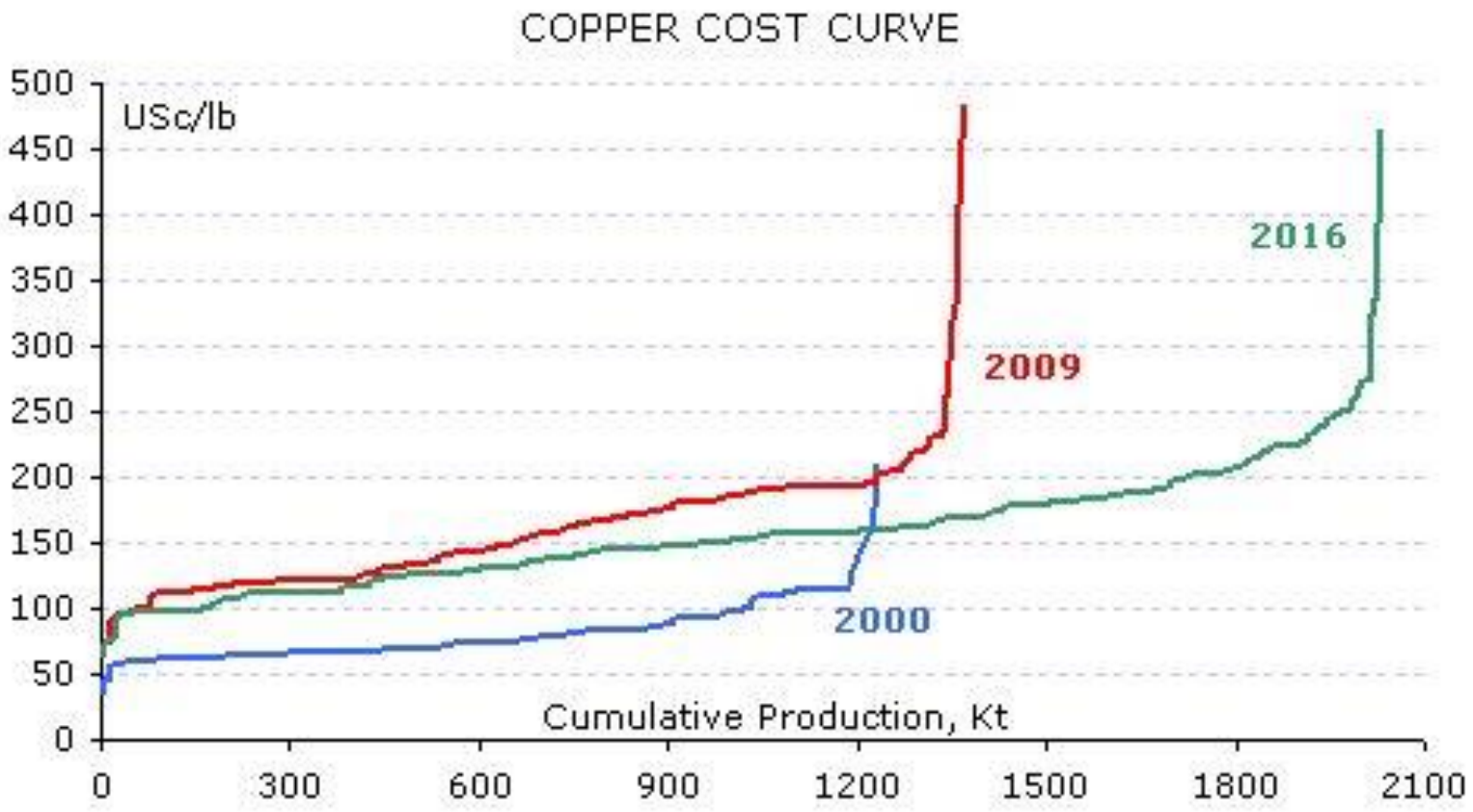


http://www.sec.gov/Archives/edgar/data/811809/000119312513400510/g613026tx_pg08.jpg

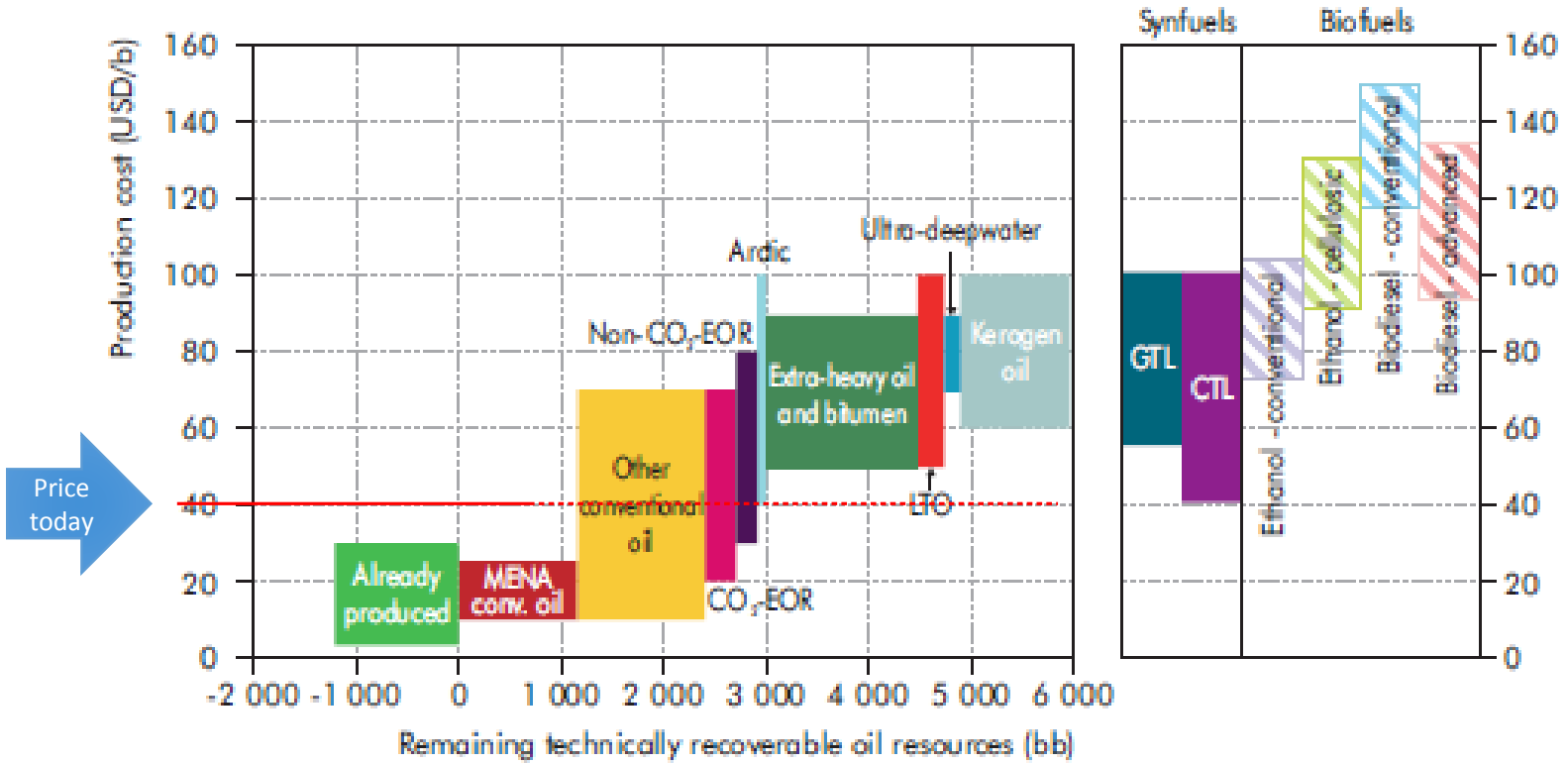
Copper example



http://www.commodityintelligence.com/7-11Feb11.htm

Oil

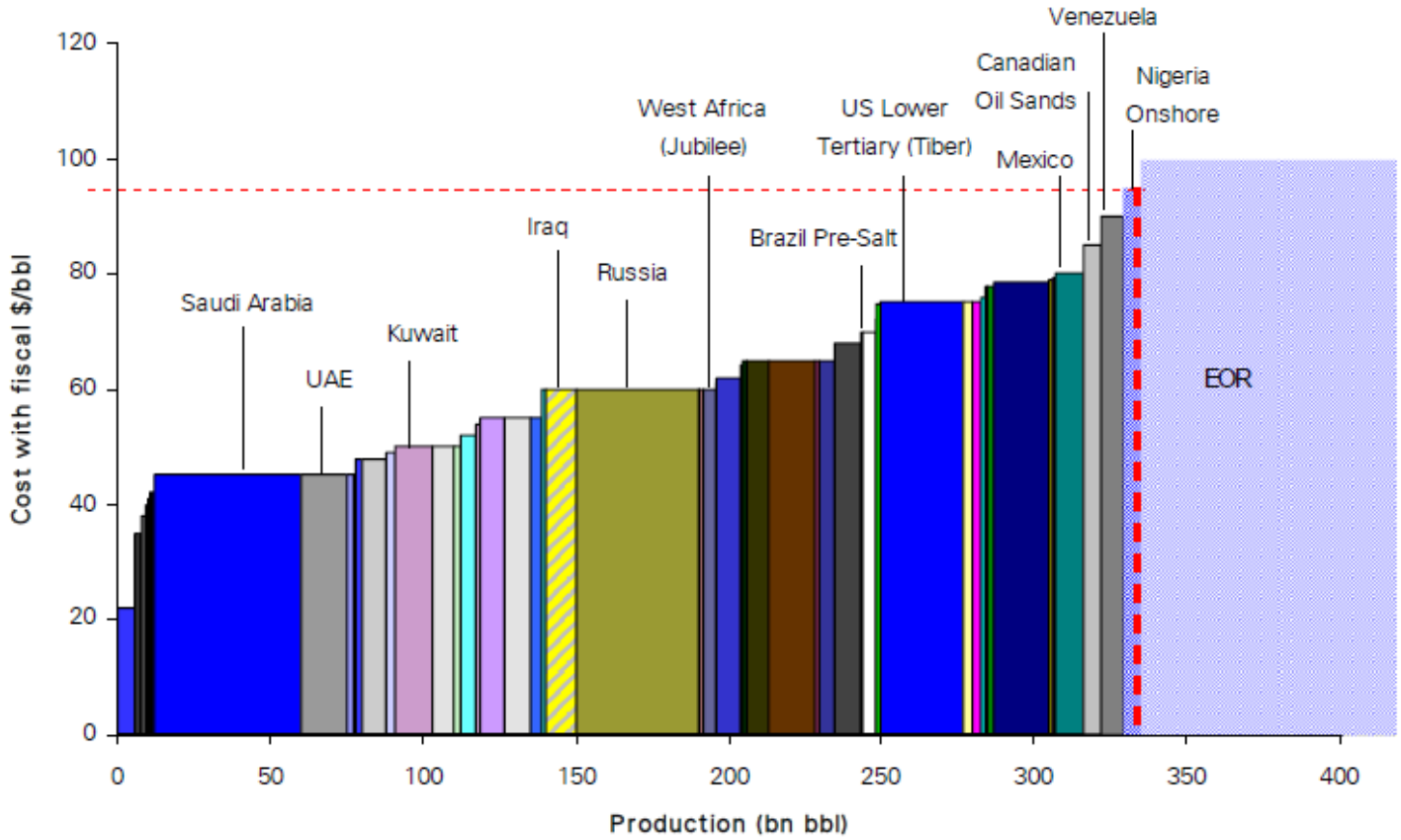
***Figure 8.3** • Oil production costs for various resource categories*



http://www.iea.org/etp/resourcestoreserves/

Oil

Figure 48: Iraq producing at 2.5Mb/d rate through 2020



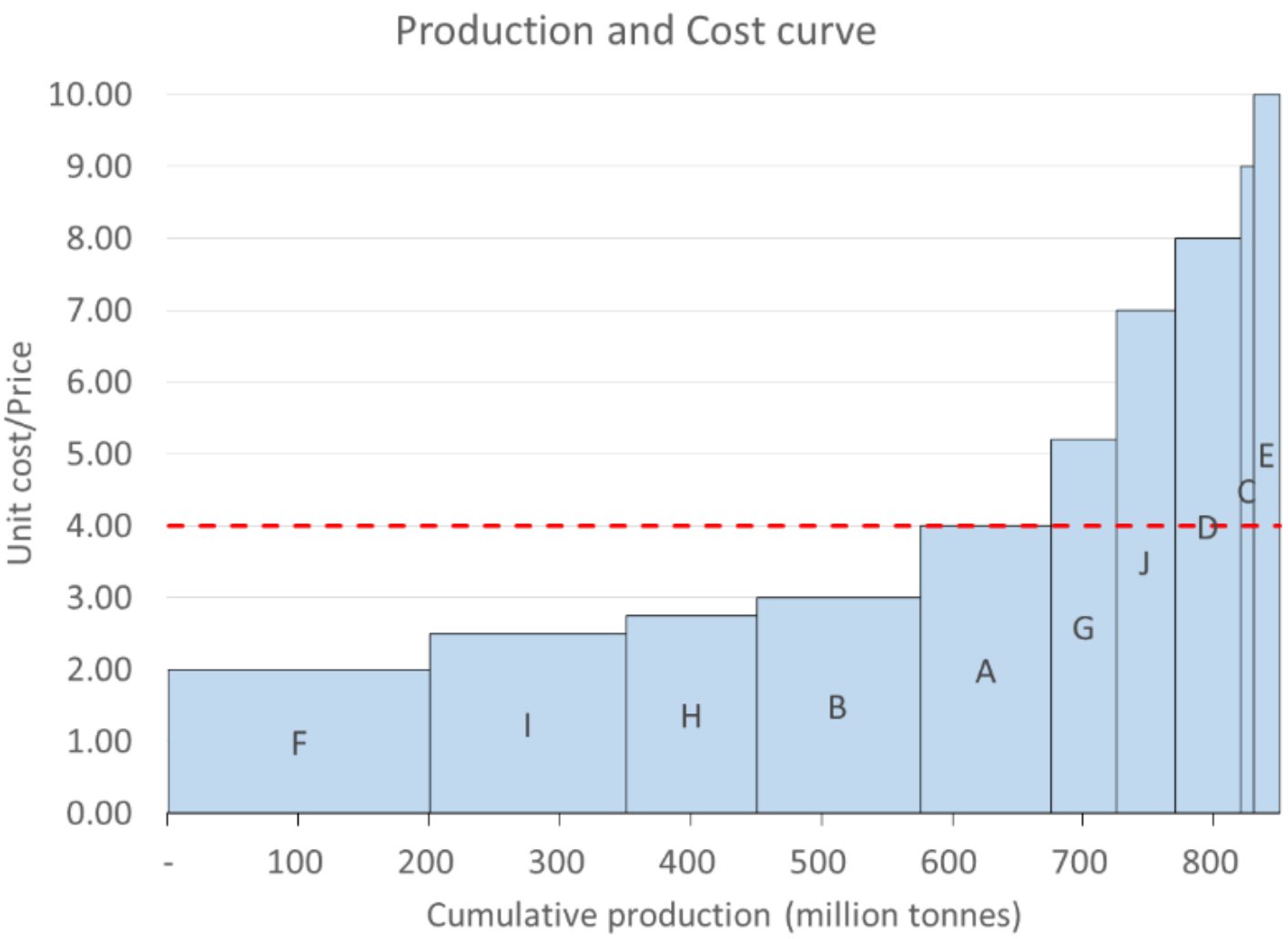
Source: Wood MacKenzie, IEA, EIA, Reuters, Company data, World Bank, Deutsche Bank estimates

http://s3.amazonaws.com/zanran_storage/www.sais-jhu.edu/ContentPages/137274942.pdf

Case study 1: building a cost curve

Imagine a particular mineral which can be produced by only 10 projects in the world.

Source data		
Project	Production	Unit cost
A	100	4.00
B	125	3.00
C	10	9.00
D	50	8.00
E	20	10.00
F	200	2.00
G	50	5.20
H	100	2.75
I	150	2.50
J	45	7.00



Cost curve cast study (questions)

1. If global demand for the mineral is 675 million tonnes, what does the price need to be to ensure production is sufficient?

2. At this price, what profit margins do projects F, make? What profit (as a % of revenue) does project A make?

3. If demand increased to 725 million tonnes, what would that imply for the price?

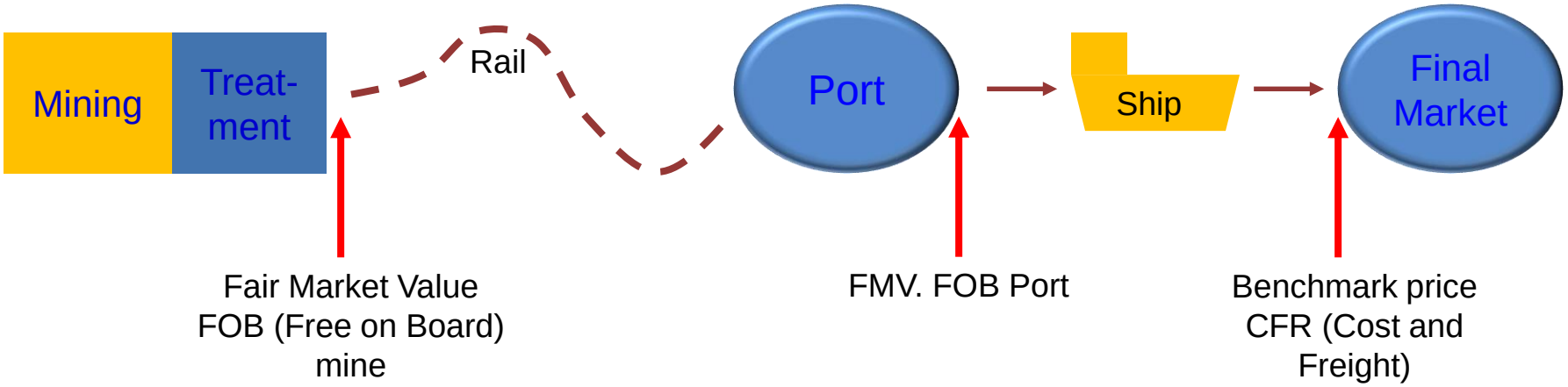
4. If demand decreased to 575 million tonnes, what would that imply for the price?

5. With demand 675 and price $4.00, what are the implications of Project I expanding production to 250?

Cost Curve: Solutions

1. If global demand for the mineral is 675 million tonnes, what does the price need to be to ensure production is sufficient?
    - All projects up to and including project A. Price needs to be $4.00
2. At this price, what profit margins do projects F, make? What profit (as a % of revenue) does project A make?
    - Project F = (4.00 – 2.00)/4.00 = 50%
    - Project H = (4.00 – 2.75)/4.00 = 31%
    - Project A = (4.00 – 4.00)/4.00 = 0%
3. If demand increased to 725 million tonnes, what would that imply for the price?
    - Price increase to $5.20
4. If demand decreased to 575 million tonnes, what would that imply for the price?
    - Decrease to $3.00
5. With demand 675 and price $4.00, what are the implications of Project I expanding production to 250?
    - Price falls to $3.00. Project A goes out of business…

Mineral valuation: example



	Value of coal in final market	Coal price benchmark
-	Shipping costs	Shipping benchmark
-	Other selling costs (insurance etc.)	Arm's length charges
=	**Fair Market Vale FOB Port**	Calculated
-	Port handling	Arm's length charges by port
-	Rail costs	Arm's length charges by rail company or actual costs incurred
=	**Fair Market Value FOB Mine**	Calculated

Project Iron Ore Mine assumptions

Project Assumptions			
Total production	M Tonnes	100	11 years
Sales price: CFR	$T	100	
Sea freight	$T	10	
Sales price: FOB port	$T	90	

Capital costs (Capex)		
Exploration costs: cash	$M	50
Exploration costs: sunk	$M	-
Development capital	$M	750
Sustaining capital *	$M per year	20

Operating costs (Opex)		
Operating costs	$T	30
Overheads	$M per year	5
Rail transport	$T	20

* From yr 2 till 3rd year before production stops

Decommissioning costs	% DevCapEx	10%

- Each item here could be broken down further: detailed cost sub-categories etc.
- Choice depends on modelling objective and access to data
- Focus in this course is on fiscal regime modelling: even this aggregated level of detail will give us plenty to analyse

Mining Case Study 1

User to populate the green cells using formulas that pick up source data to derive pre-tax net cashflows for the project over its whole life

Project "X" Single Period Model						
Pre-tax cashflows						$M
Revenues		MT		$T FOB port	=	-
Exploration costs						
Development costs						
Sustaining capital		$M/yr		years		-
Operating costs		$T		MT	=	-
Overheads		$M/yr		years	=	-
Rail transport		$T		MT	=	-
Decommissioning		% DevEx		$M DevEx	=	-
Total costs						-
Net cashflow before tax						-

Data sources in practice

Mining Company: best source
Feasibility studies (EDGAR etc.)
Technical colleagues: Sector ministry
Rules of thumb
Analog projects

Getting good project data out of companies can be challenging…

- Make it a legal requirement
  - Pre-feasibility; Feasibility; Development plan; Annual updates; "Life of Mine" Plans
- Maintain effective working relationship
- Establish agreed formats/templates
- Formally acknowledge that things change: Actual ≠ Forecast
  - Companies are hesitant to provide data if they will be held to a previous forecast
- See later discussion on revenue forecasting

Fiscal Tools

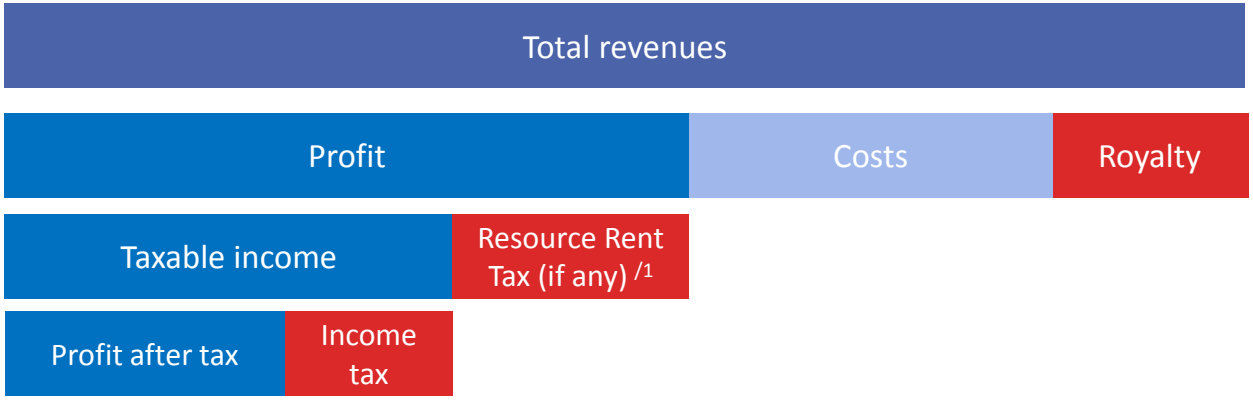
Royalty	A share of the value of production 3-5% pretty common, rates often vary by mineral
Income tax	A share of profit, determined under tax rules 30% rate pretty common
Resource Rent Tax	Special tax designed to capture a share of economic rent. Uncommon but often recommended by the IMF
Import duties	% of the value of imports
Value Added Tax	% of sales (output VAT) and % of costs (input VAT) Under properly functioning VAT the consumer should bear the cost – not the mining company. But in practice…
State participation	Government owned company owns a share in the project
Others	Withholding taxes on subcontractors Withholding taxes on dividends and interest

Investment theory: Time = Money

If you have money you can (a) spend it or (b) invest it
You need to be compensated for deferring consumption, which is why interest rates are positive
You have $1.00 and invest it in a bank for 5 years earning 5% interest
How much is that $1.00 worth in 5 years? $1.28

Interest rate		5.00%				
Year		1	2	3	4	5
Opening Balance		0.00	1.05	1.10	1.16	1.22
Investment		1.00				
Interest		0.05	0.05	0.06	0.06	0.06
Closing Balance		1.05	1.10	1.16	1.22	1.28

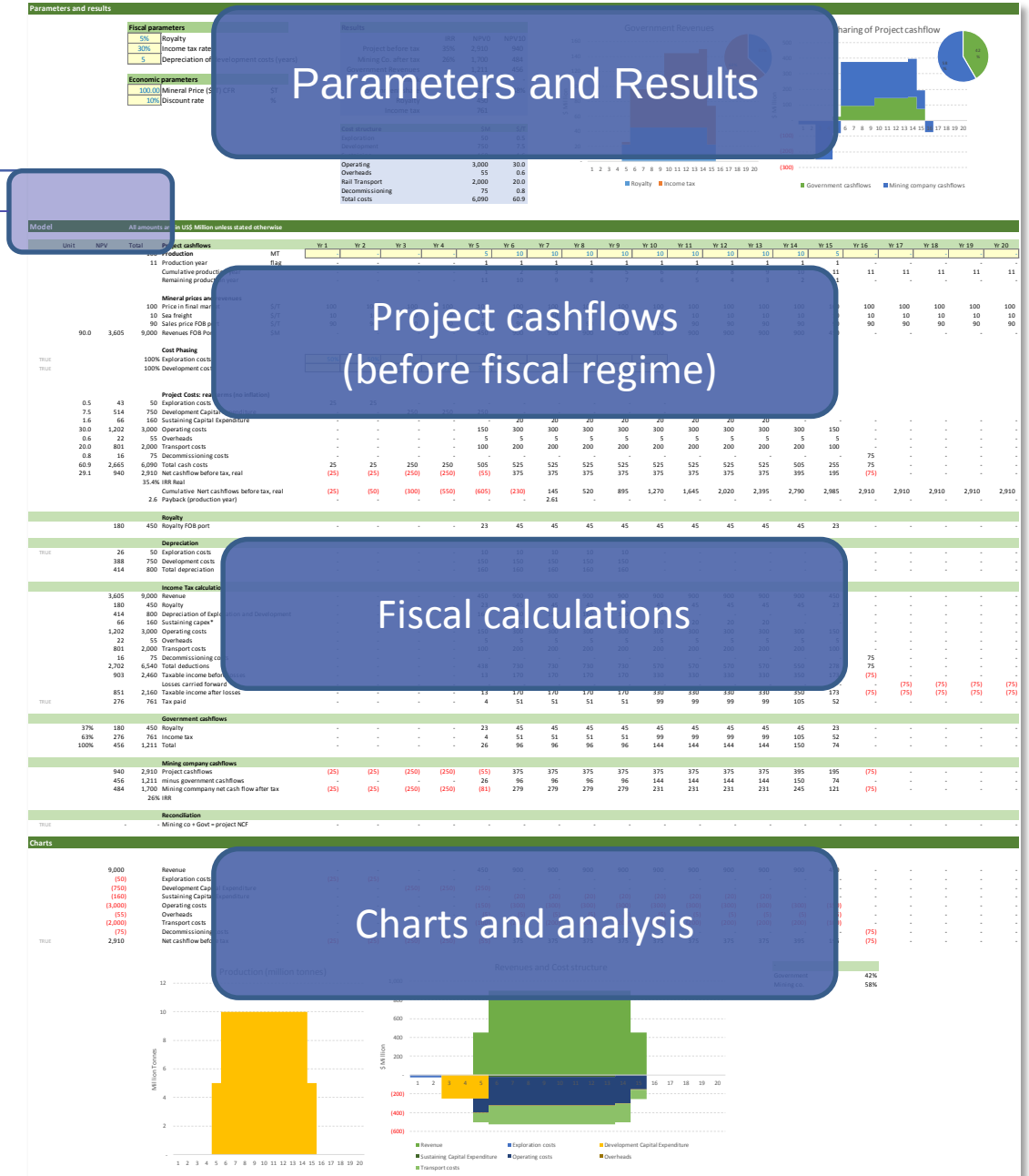
Generic Mining Fiscal regime



1/ Assuming the RRT is deductible

Columns on left
- Total
- NPV
- Unit $/tonne
- Checks

Annualized model picks up cost inputs from the single column model. If we update the project inputs on that sheet, the annualized model will automatically update



Walk through annualized model

Deriving pre-tax cashflows

- Building a production profile
- Building the mineral price FOB port each year
- Phasing of exploration and development costs
- Phasing of sustaining capital
- Operating costs
  - Discussion on fixed versus variable, but simplified 100% variable approach in this model
- Phasing of Overheads
- Rail transport costs

- Note that the net cashflow before tax is the same as the single period model

Mining Model: what-ifs

Government

- What price would be needed to ensure $1 billion to the government over the project life time? Or $1.5 billion?
- What royalty rate would be needed to ensure $1 billion to the government over the project life time? Or $1.5 billion?

Investor

- What mineral price would result in 15% project Internal Rate of Return for the investor (IRR)?
- What happens to the IRR if we increase the commodity price by 10%?

Interaction Between the Two

- What happens to government revenues if there is a cost overrun of $500 million?

Petroleum Project Lifecycle

- Consider alternative countries (EMV* analysis)
- After evaluating government sponsored seismic
- Compete in licensing round

- More detailed (3D) seismic survey
- 4D seismic surveys
- Petrophysical analysis
- Evaluate petroleum system potential
- Identify drilling targets

- With first well success…
- Drill further wells to delineate the size and productive properties of the reservoir

- Front End Loading
- Front End Engineering and Design (FEED)
- Detailed Engineering
- Final Investment Decision
- Financing

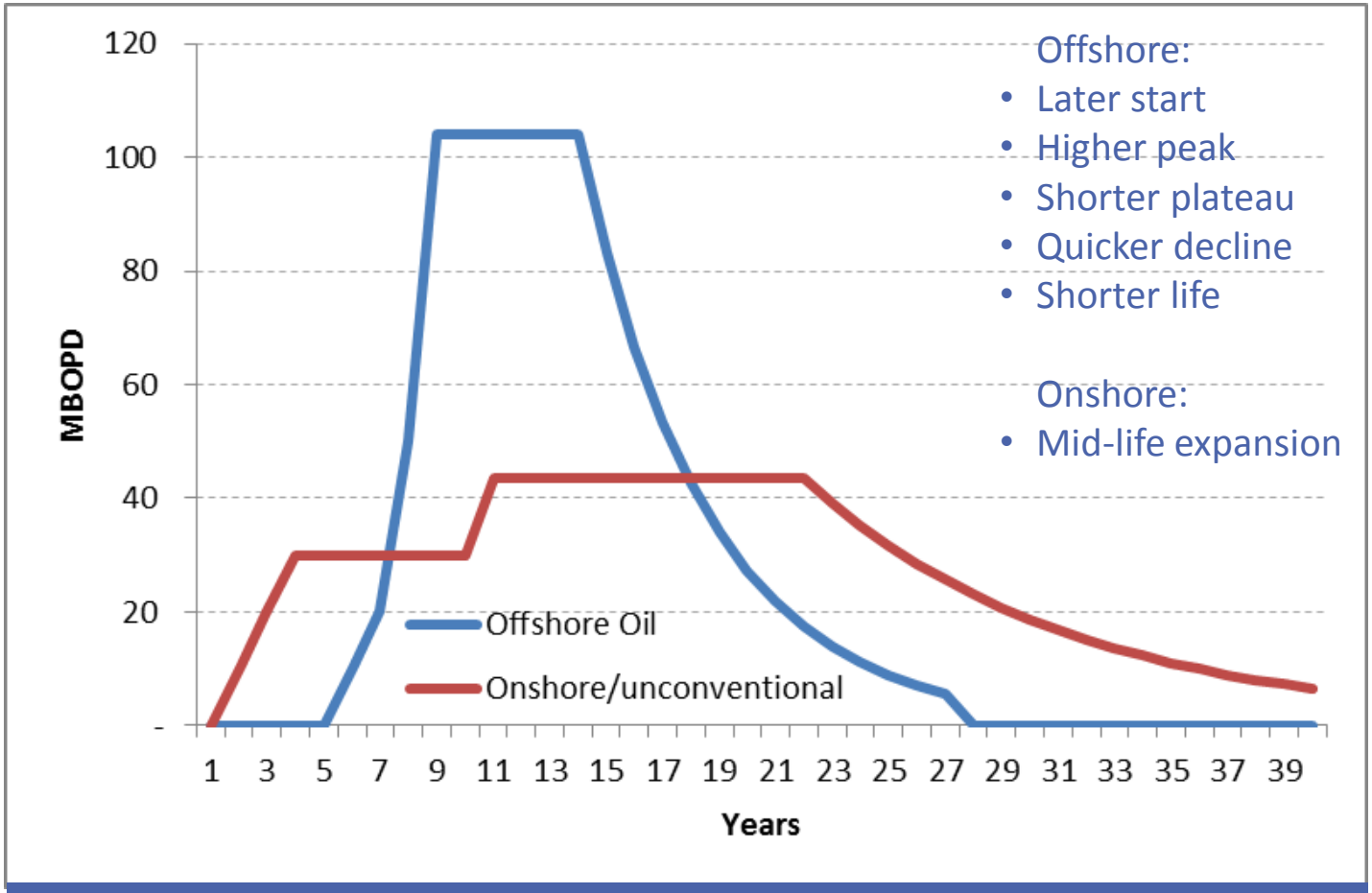
- Operate the project
- Optimize production
- Minimize costs

- Primary recovery
- Secondary recovery
- Tertiary recovery methods

- Plug and abandon wells
- Dismantle facilities

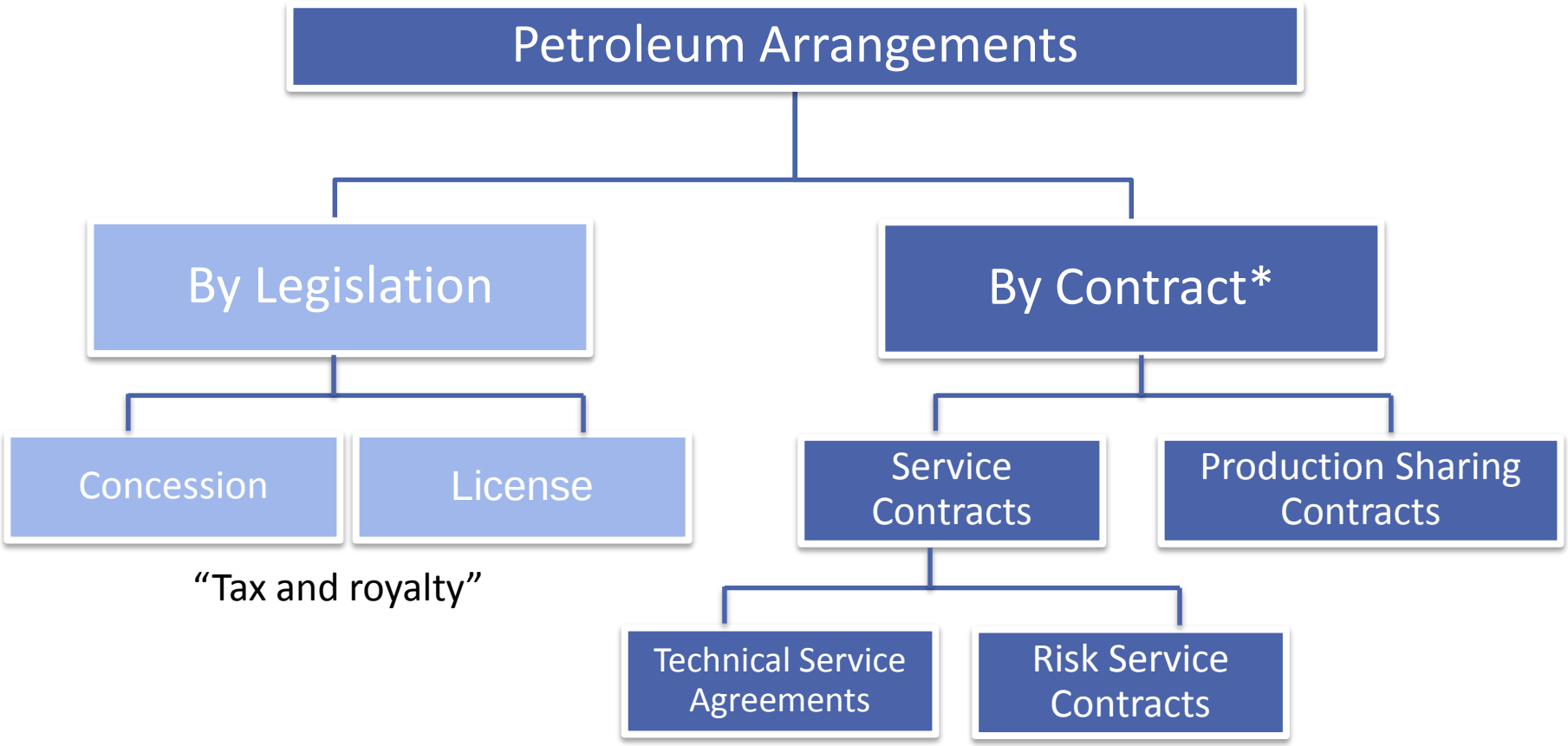
* Expected Monetary value. See later in the course

Onshore vs Offshore Production Profiles



These two profiles both produce around 400MMBbl

Types of Petroleum Arrangements



"Tax and royalty"

**Within enabling legislative framework*

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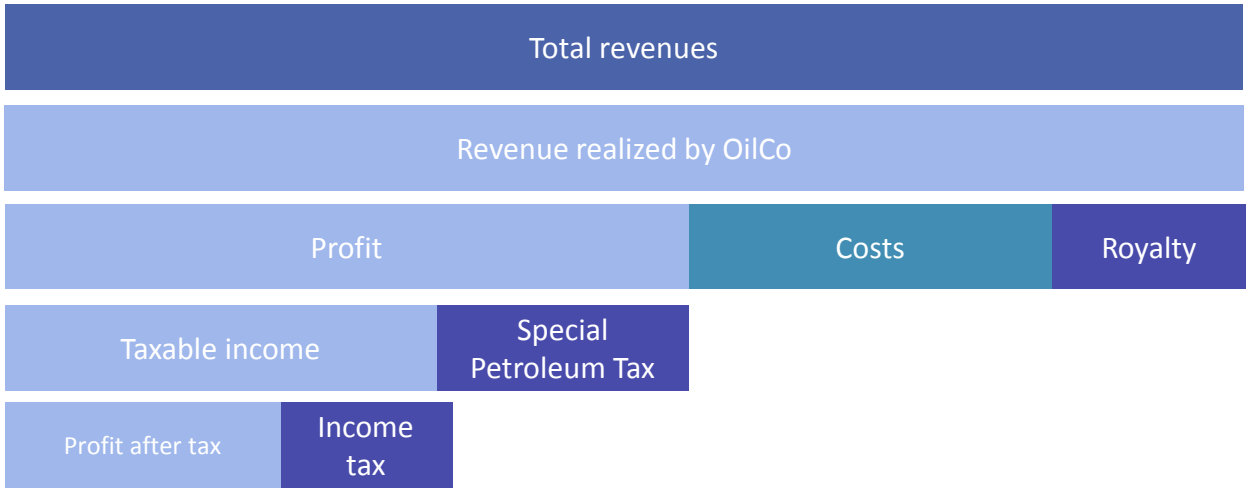
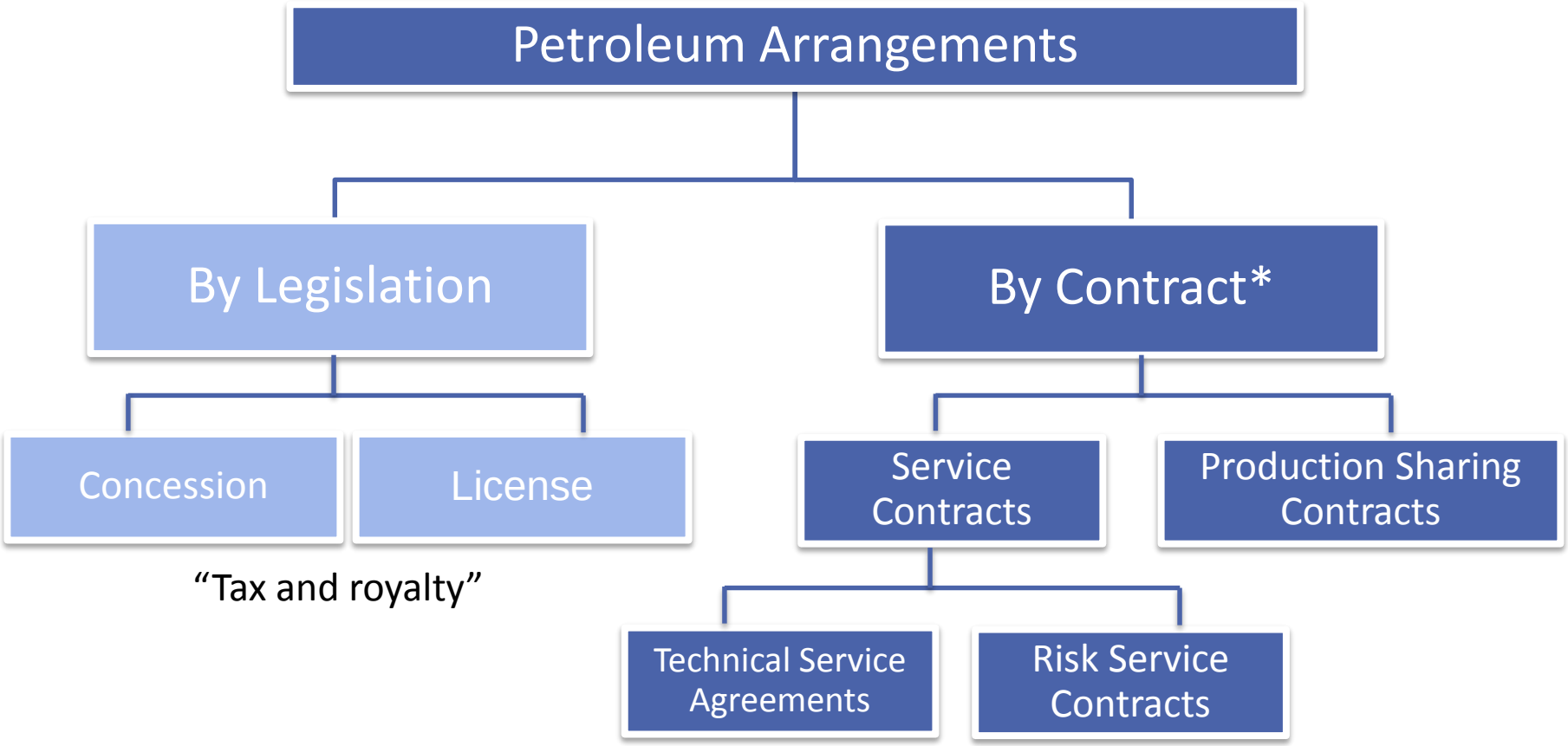
“Tax and Royalty” regime for oil

OilCo licensee books 100% minus royalty



Same as mining tax regimes, though because of the potential for higher rent, royalties and tax rates are often higher than mining

Types of Petroleum Arrangements



"Tax and royalty"

**Within enabling legislative framework*

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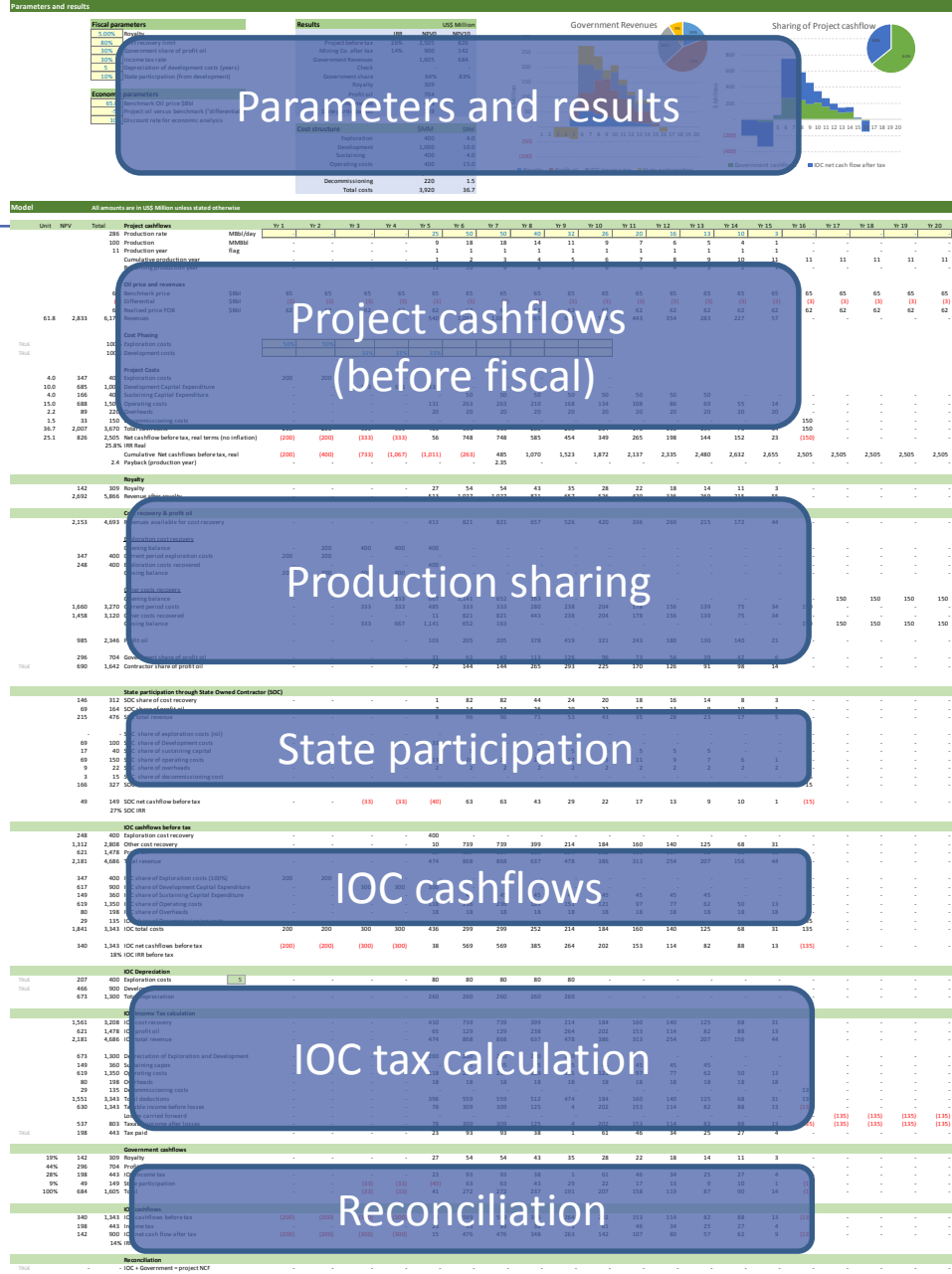
Oil Model structure

More complex than mining model:
Production Sharing
State Participation



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Real 1: Bulyanhulu Gold, Tanzania

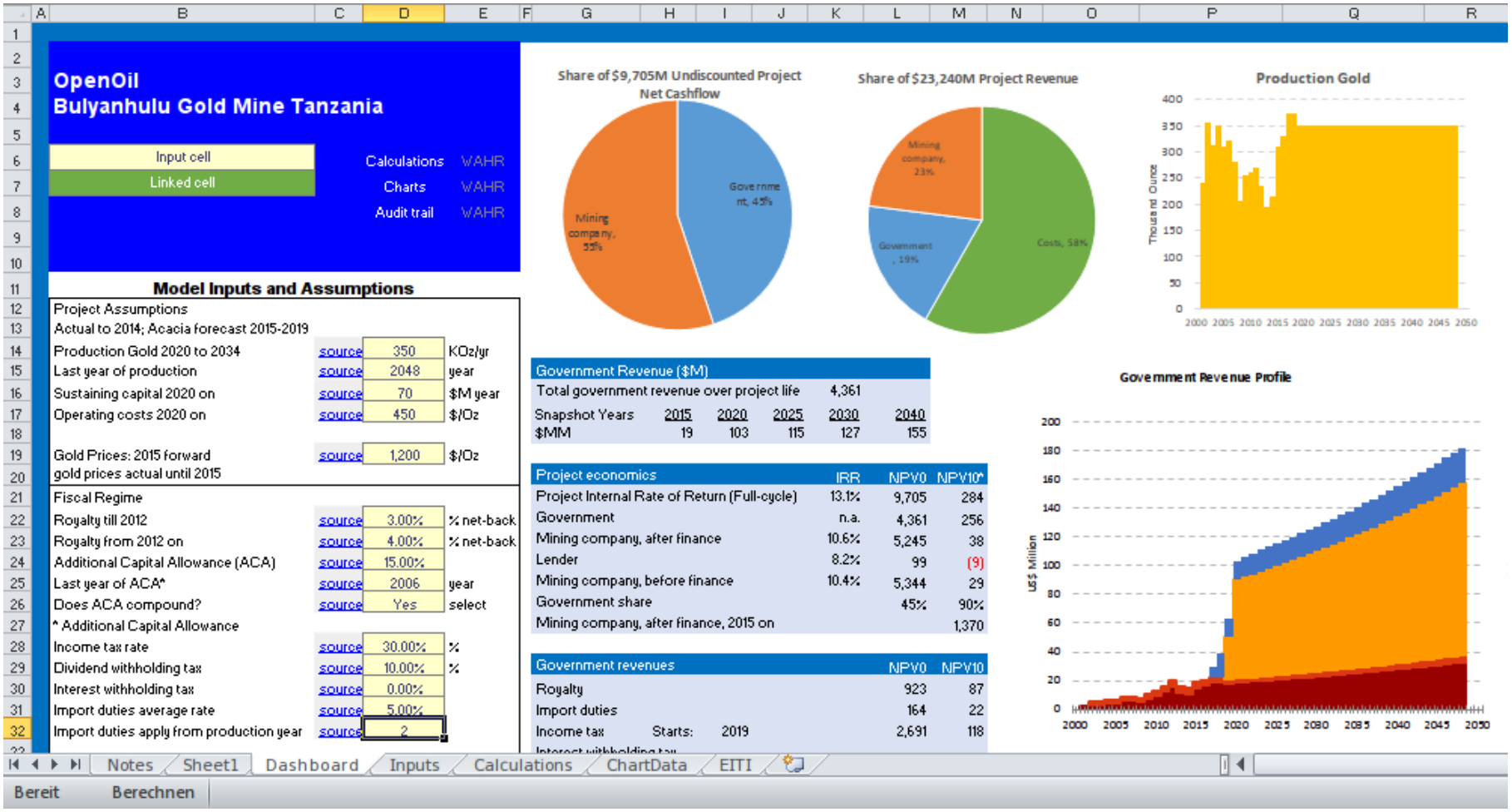
Context

- Started production in 2001
- Over three million ounces of gold
- Barrick Gold spun off (2010) to separately listed Acacia Mining
- Model: historical production & prices; estimates into the future

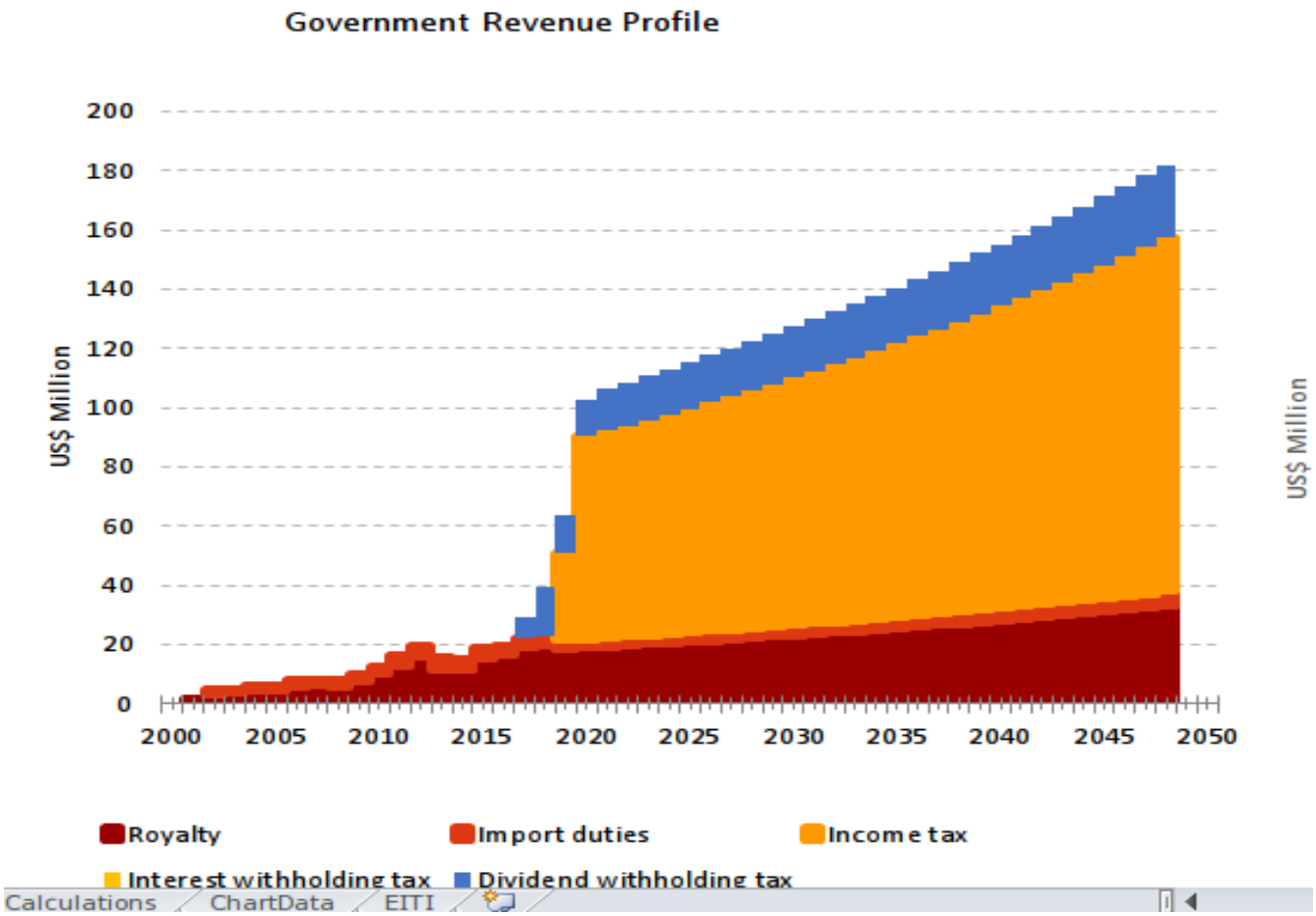
Now: income tax dispute

- Still no income tax
- Acacia announced (March): pre-payments of income tax
- Tanzanian court: Acacia owes $42 million dividend witholding tax; company disputes

Buly model overview



Buly model: where is income tax?



Case 2: Oyo Tolgoi, Mongolia

Context

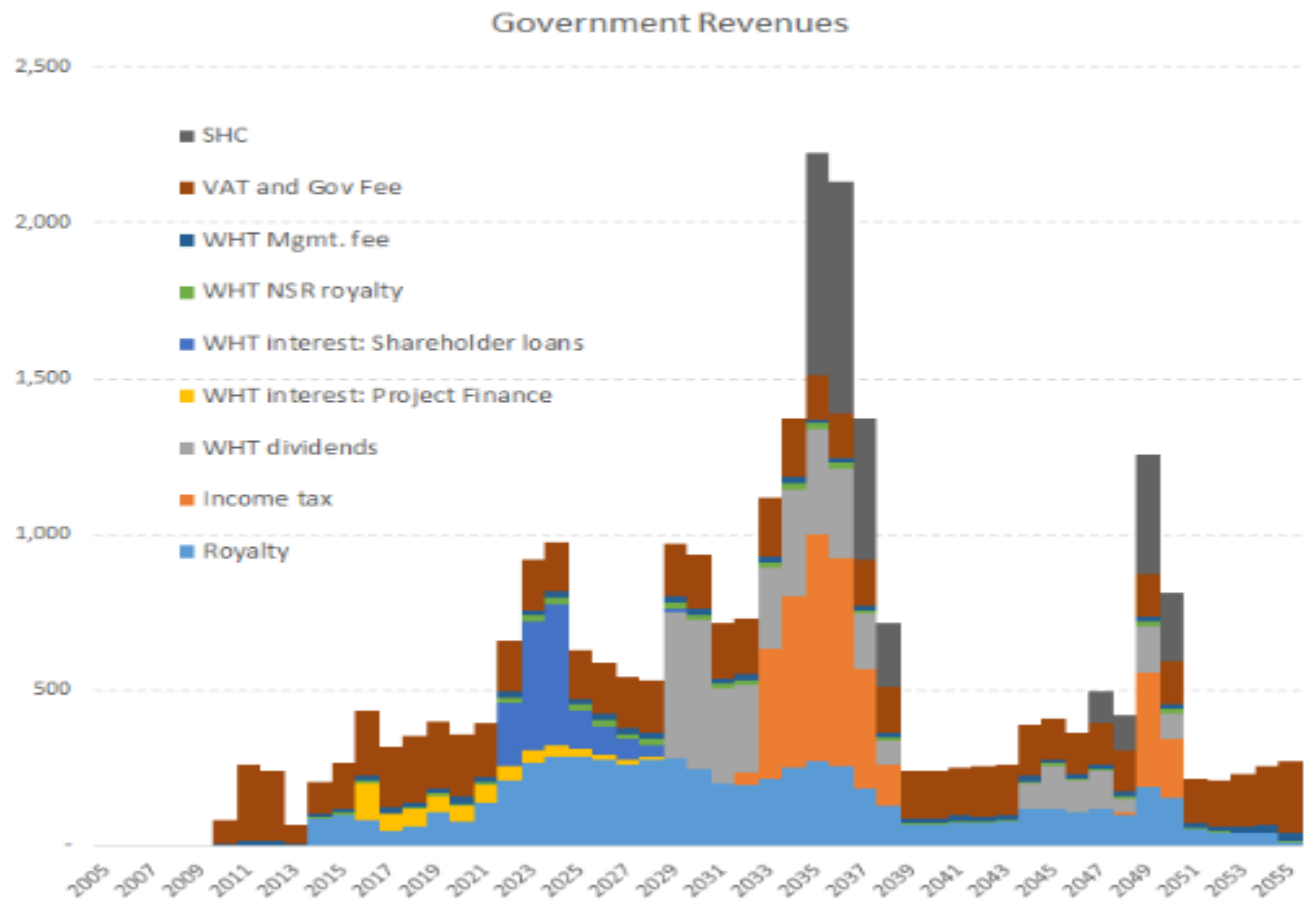
Copper and Gold mine signed in 2002
Taken over by Rio, through an entity called Turquoise Hill
Government negotiated hard fought 34% stake in the venture

Now

Highly sensitive to prices: 2010-55 NPV is negative in today's prices
Withholding taxes and VAT are significant in early life
The state participation does not earn money until the mid-2030s

Oyo Tolgoi: Waiting for state %

Figure 5: Revenue profile for base case (nominal $ million)



Has modeling been hard to build?

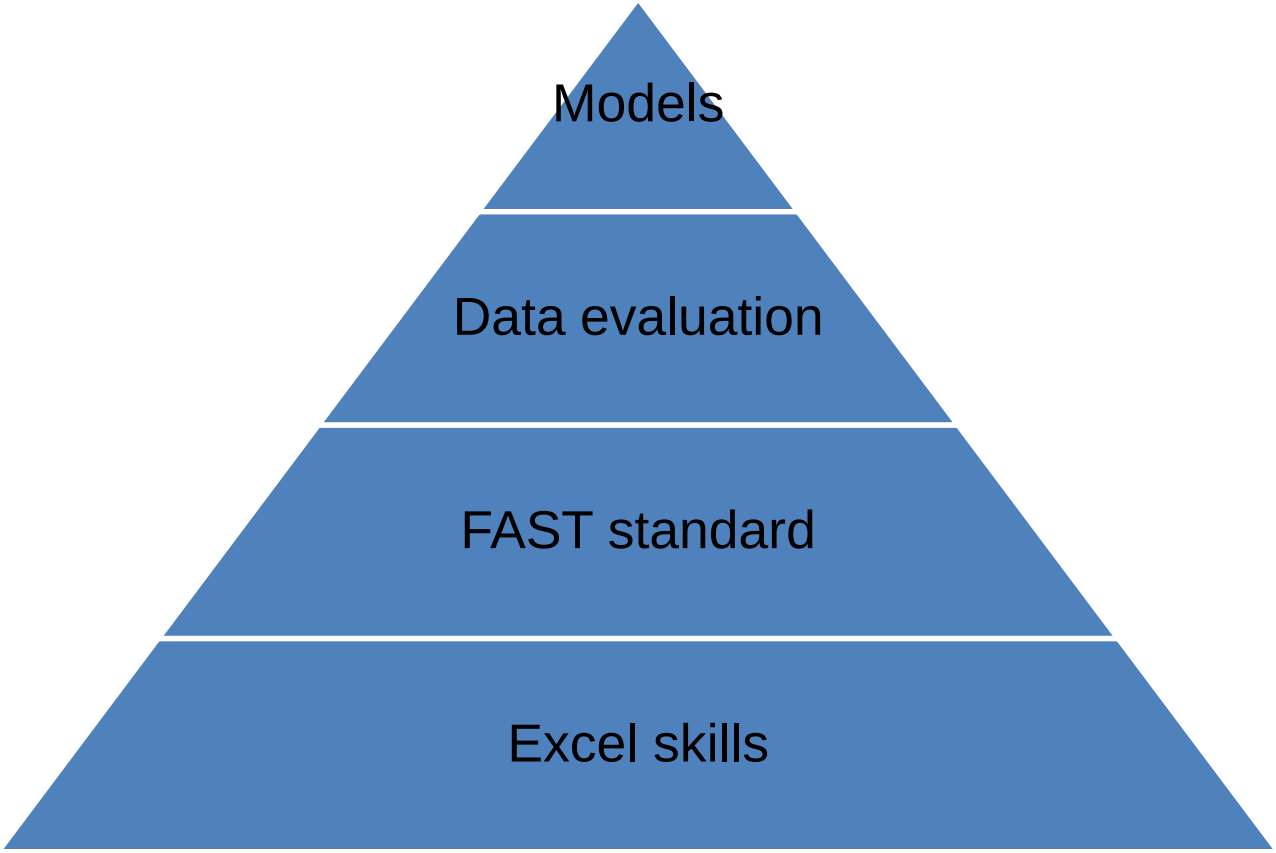
Challenges:

- Complex
- Non-standardised
- Non-adapted: each model should answer specific questions
- *Leading to: Slides in presentations, not full workings in model*

Ways to meet those challenges:

- Standardised modeling methodologies across agencies & countries
- Full source citation integrated into model
- Open modeling processes leading to direct peer review
- *Leading to: a Public Financial Management paradigm of modeling*

Skills pyramid for modeling capacity



the Single Number Super-model