Assessment Task 3: Visual Analytics

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1. Introduction

Objective

Writing a report targeted at individuals within public policy circles or government, to summarize key findings about Australian trade data.

Data Source

The given dataset consists of raw dollar values of imports and exports for a range of categories and subcategories, each with their respective year on each row..

Methodology Overview

To accomplish my objectives I will be using Tableau to create visualizations and Excel for pre processing and conduct research to better my understanding of the data at hand.

2. Data Preparation and Methodology

Analytical and Statistical Pattern Creation

I followed these two formulas to create a new worksheet called statistical patterns in excel.

Percentage (i-import) = *sub-total (i-import)* / *total (import)*

Percentage (i-export) = *sub-total (i-export)* / *total (export)*

where total *Percentage (i-import)* and *Percentage (i-export)* should be 100%

Percentage-Sub $_{(j\text{-}import)}$ = $d_{(j\text{-}import)}$ / *sub-total* $_{(j\text{-}import)}$

Percentage-Sub $_{(j\text{-}export)}$ = $d_{(j\text{-}export)}$ / *sub-total* $_{(j\text{-}export)}$

where $d_{(j)}$ is data at sub-category *j*, and total *Percentage-Sub* $_{(j\text{-}import)}$ and *Percentage-Sub* $_{(j\text{-}export)}$ should be 100%

I followed this formula to create a new worksheet called analytical patterns in excel.

For time series t = 1988, 1989, ,,, 2022; ratio of change for category (i) or sub-category (j) between *t* and *t-1* can be denoted as

Ratio_Change $_{(t)}$ = $d_{(t)}$ / $d_{(t-1)}$

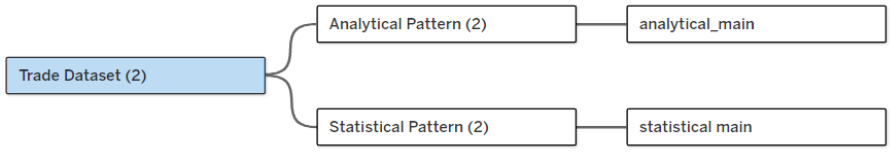
where $d_{(t)}$ is data for category (i) or sub-category (j).

These calculations, such as percentage shares, growth rates, and import/export ratios, are essential for understanding trade patterns because they allow us to see how each category contributes to the overall trade landscape over time. By calculating the percentage share of each category, we gain insights into the relative importance of each area, helping to identify which categories are dominant or growing.

Growth rates reveal trends over time, showing whether a category is increasing, stable, or declining, which can indicate shifts in demand or supply. Import/export ratios help us understand the trade balance within each category, highlighting areas where the country may be import-dependent or export-focused. Together, these calculations provide a clearer picture of trade dynamics, making it easier to analyze patterns and detect significant shifts or change points across categories.

Import to tableau

I imported 5 tables from my excel file.



Analytical pattern for growth rates, statistical for percentage shares, trade dataset for raw trade values and the “main”’s on the far right to access main category values since the data has been unpivoted.

Important Notes

For the trade dataset, the dataset was pivoted and i didn’t include the totals maybe i could have i don’t know, but instead i just used the aggregation that tableau provides, the problem here is that the values aren’t 100% accurate since the raw dollar values provided were rounded to the whole numbers, but i think it's accurate enough to reflect the totals, so i just continued using the sum aggregation, by continuing like this, my findings won't be different in the sense that it shows the same trends and outliers, but the data values will be slightly different, but still close to the real value.

3. Visualization and Analysis of All Main Categories

Raw Dollar Value Trends

I wanted to get a good comparison of the total dollar value of the imports and exports of Australia by using a **pyramid chart** to provide insights into trade balance patterns, like whether imports or exports are more dominant in a given year. (Organisation Chart would benefit here)

Graphic Techniques

I used two colors in general to help distinguish total import and exports, I aligned the headings at the top in a ordered way to identify which bar chart corresponds to which trade type, I made sure the x axis for both bar charts were in the same range to stay consistent and accurate (0B to 600B) and labeled the x axis “Total Trade Value (AUD Billions)” for better context and readability and y axis “Year” to demonstrate the time series nature

Trends

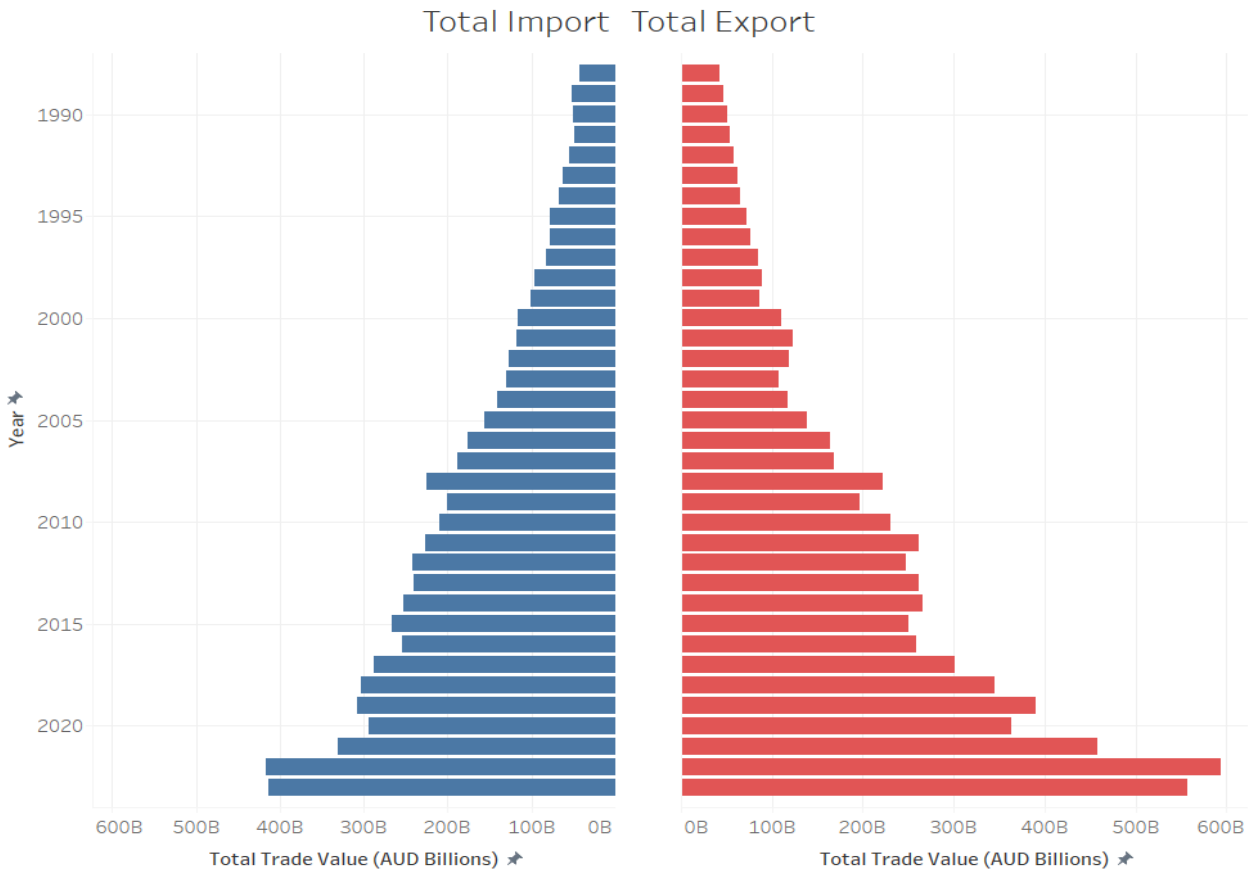
- Both imports and exports have shown a general upward trend from 1988 to 2023, indicating an increase in Australia's overall trade activity.
- From around 2010 onward, there's a noticeable widening between total imports and exports, with exports increasing at a slightly faster rate.
- Starting around 2020, exports have grown more steeply, which could be attributed to the **global demand for Australian resources** like iron ore, coal, and agricultural products.
- In contrast, imports have shown some stabilization after 2020, suggesting a potential change in consumption patterns, import restrictions, or domestic production substituting for imports.

Outliers

- The sharp increase in exports post-2020 could be considered an outlier given its rapid growth compared to previous years.
- The lower trade volume in the early years (pre-1995) might be an outlier relative to recent data

Perspective (from outside research)

Australia's export growth since 2020 can be attributed to several factors, primarily a surge in demand for resources and energy commodities like iron ore, coal, and natural gas. This demand was driven by strong global market prices and Australia’s strengthening trade relations with China, which increased imports of Australian goods, especially critical minerals like lithium, essential for China’s technology and electric vehicle sectors. Additionally, the lifting of tariffs and bans on products like Australian wine and beef contributed to export gains. The easing of COVID-19 restrictions further supported the recovery of Australia’s services exports, especially in education and tourism. Government initiatives, such as the Critical Minerals Strategy, also played a role by boosting exports of critical minerals. These combined forces reflect Australia’s rising export performance and highlight its role as a key global supplier of essential resources.



Analytical Trends

To look at all categories using analytical trends I decided on using the growth rate based on the total raw dollar value given from the dataset, this way I'm able to analyze all the categories. A **multi line** chart i think was effective as the visualization compared to other visualizations especially if it's well labeled like my one.

Graphic Techniques

The main graphic technique used here are the text labels, which guides the reader to key economic events that happened during specific time periods making the visual more like a story through time. The lines were based on trade type with a legend showing the color for each trade type improving differentiability and readability. Referenced lines were also key to this visual helping differentiating maximum growth rate, minimum growth rate, average growth rate and base growth rate. The y axis was a percentage to better highlight the growth rate and I made sure axis labels and titles were all appropriate.

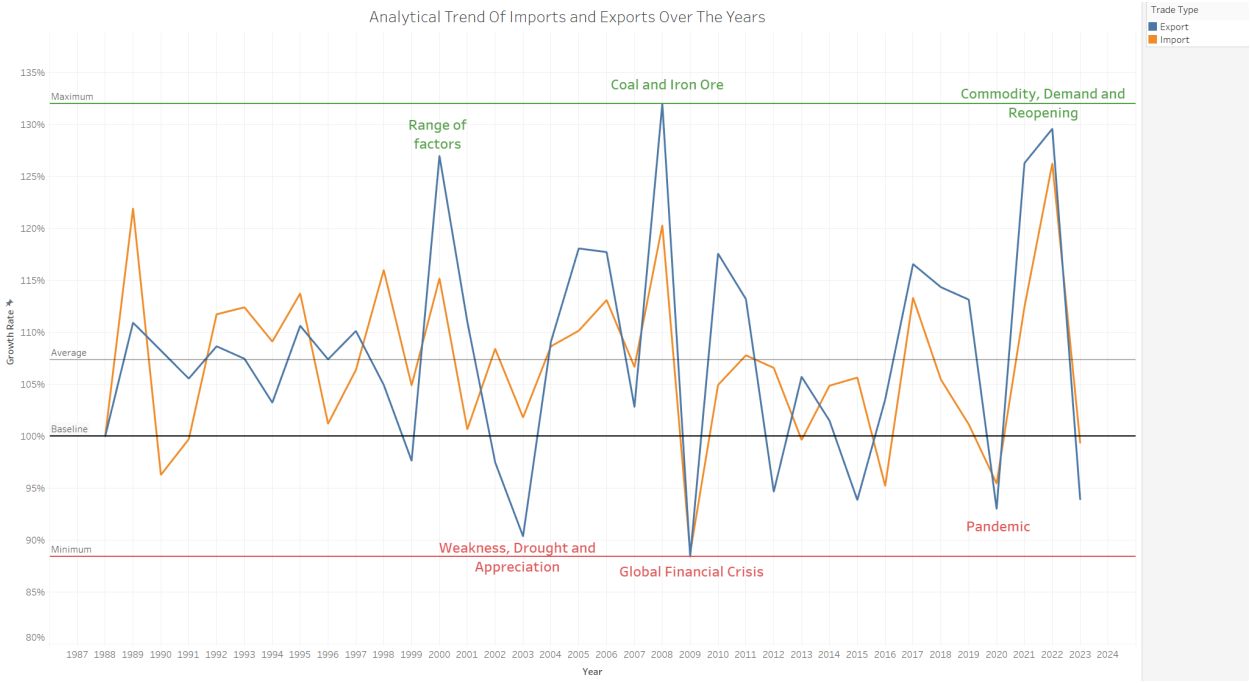
Trends

- Both import and export growth rates fluctuate over time without a clear linear trend, indicating a volatile trade environment.
- Between 1991 and 2000, there's a relatively stable fluctuation in growth rates, staying mostly within the 100-115% range. This suggests a period of relatively consistent trade growth, with no extreme spikes or dips.
- After the Global Financial Crisis in 2008, both import and export growth rates dip sharply below the baseline (100%), indicating a contraction in trade. However, this is followed by recovery and growth through the 2010s. Exports, in particular, show a pronounced spike following this period, likely driven by rising demand for Australian commodities.
- Around 2020-2021, there's another noticeable dip in growth rates, attributed to the COVID-19 pandemic. This period likely reflects supply chain disruptions, decreased global demand, and other pandemic-related economic effects.
- In recent years, exports show a sharp increase

Outliers

- Both import and export lines show a sharp dip during the 2008-2009 period, reflecting the impact of the Global Financial Crisis. This is one of the most pronounced declines in the visual, marking it as a major outlier.
- Export growth spikes sharply at 2008, likely due to a peak in global demand for commodities such as **coal and iron ore**. This is an outlier above the usual range, marking a high point in Australia's export growth.
- There is a dip in both import and export growth during the **2020-2021 period**, which aligns with the global economic impact of the COVID-19 pandemic. This sudden contraction reflects disrupted supply chains and reduced global trade activity.

- In 2022, exports show another steep increase, possibly tied to **commodity demand** and **global reopening** post-pandemic. This is another high outlier and suggests a strong rebound driven by high demand in specific sectors.



Statistical Trends

To look at all categories using statistical trends was a bit harder, but i came up with a perfect visualization using **multiple stacked vertical bar charts** this helps quickly identify which main category dominates and is a minority, but with a time series element all condensed to make the visual very informative. (Sankey and Chord Diagrams Had Great Potential Too)

Graphic Techniques

The main graphic technique is the type of chart itself which is a multiple stacked vertical bar chart, by having multiple vertical bar charts that have segments representing different trade categories, the reader can clearly see the bigger picture through different dimensions such as time, category, Proportion of Total Trade and Import vs. Export. The colors are consistent for both import chart and export chart making the visual more simple and clear, with a legend showing the main category the color corresponds to which color, the y axis is only on the left, no need for extra since its measuring both charts and is a percentage which is good for this context, lastly i made sure the other parts such as title were all appropriate.

Trends

- **Machinery and transport equipment** (shown in purple) dominate the imports, indicating Australia's reliance on these goods.

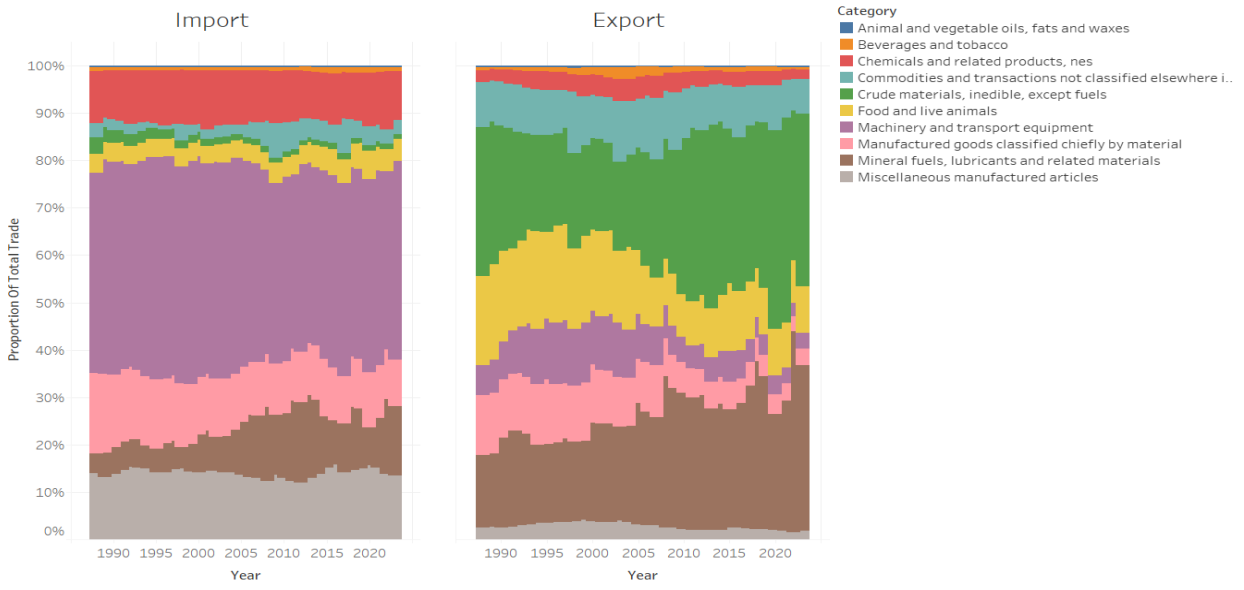
- The **imports chart** shows relative stability over time, with the main categories maintaining a fairly consistent proportion of total imports.
- The **exports chart** shows more variation over time, with noticeable shifts in the relative importance of certain categories.
- Unlike imports, which are more concentrated in a few categories, **exports** show a wider range of categories that contribute meaningfully to total exports.
- Over the years, **commodities** and resource-based categories, such as **Mineral Fuels** and **Crude Materials**, have increased their proportion of total exports. This highlights Australia's shift toward becoming a primary supplier of raw commodities to meet global demand.

Outliers

- The proportion of **Manufactured Goods** (pink) in exports declines steadily, suggesting that Australia's export economy has moved away from manufacturing and become more resource-focused. This decline is an outlier, as it contrasts with the stability or growth seen in other categories.

Perspective (from outside research)

Australia's shift toward a resource-focused export economy over manufacturing is driven by several factors. The country's rich reserves of minerals and energy resources, particularly iron ore and coal, have made it a key global supplier, especially for growing markets like China. At the same time, high production costs have reduced the competitiveness of Australian manufacturing, pushing industries to source goods from countries with lower costs. Additionally, government policies have historically supported resource extraction over manufacturing, and advancements in automation have lowered the demand for a manufacturing workforce. Together, these factors have reinforced Australia's emphasis on raw commodity exports while manufacturing's economic role has diminished.



4. Analysis of Main Category-Subcategory Relationships

For this step I couldn't look at all the categories so I just selected a onebased on the big picture of all the categories I've obtained shown in the previous pages.

Machinery and transport equipment (import)

Statistical Analysis

I chose to look at this category and its underlying categories because it was the most consistent and dominant category based on its proportion of total trade for the import trade type and wanted to see what was the key sub category driving this main category. For this purpose I could've gone with a multi line chart, but instead I used **box and whisker plots** since they provide more details on statistics which might be unnecessary, but is good for visuals as well. The only problem is it doesn't really show the time progression that well.

Graphic Techniques

I just went with a blue color scheme with a modern look, colors aren't that important here. I made sure the values were not aggregated in order to be able to make the multiple box and whisker plots since "show me" wouldn't work. I made columns for each sub-category and put filters only selecting import and machinery and transport equipment. I made sure to fit in the subcategory names and made the title big enough to identify them. Percentage for y axis for better interpretability.and an appropriate y axis name.

Trends

- Most of the proportions for the sub=categories range from 18% to 8% showing similar patterns of change over the years
- Road Vehicles takes up bigger portions compared to the other subcategories showing its significance for the main category
- Metal working machinery is the minority sub-category taking up only a small fraction of 0 to 2% showing that it has a insignificant effect for machinery and transport equipment category

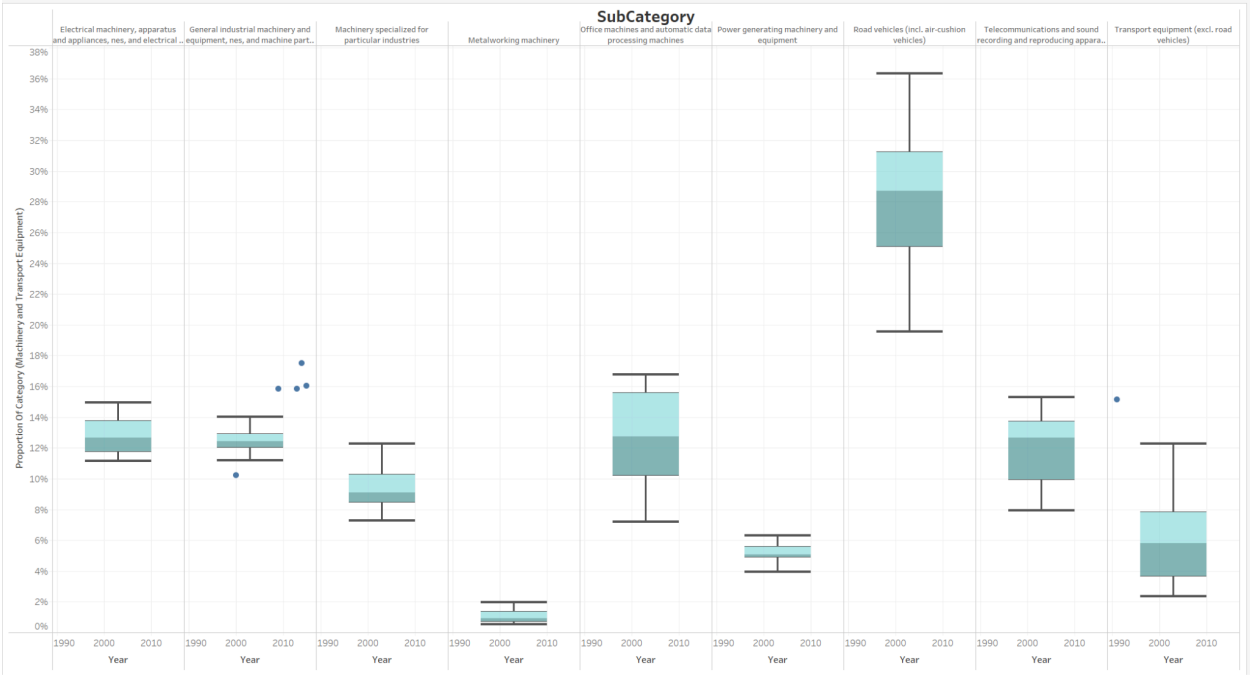
Outliers

- There are a few noticeable outliers above the main distribution in the "General industrial machinery and equipment, nes, and machine parts" subcategory, indicating occasional spikes in its proportion during certain years.
- Transport equipment also has one distinct outlier, likely indicating an exceptional year where the proportion was notably higher than usual.

Perspective (from outside research)

Road vehicle imports make up a significant portion of Australia’s machinery and transport equipment imports due to a combination of high domestic demand, limited local manufacturing, and diverse vehicle needs. Australia’s large and geographically dispersed population drives demand for a wide variety of vehicles, from passenger cars to specialized commercial trucks, many of which are now sourced from abroad due to the decline in local automotive production. Furthermore, unique terrain and conditions across the country necessitate different vehicle types, such as off-road models for rural areas and fuel-efficient cars for urban environments, adding to the import volume. Additionally, technological advancements, particularly in electric and hybrid vehicles, are often developed overseas, prompting increased imports to meet consumer demand for these new features. Finally, Australia’s trade agreements facilitate the import of vehicles, making it economically feasible to source them globally. Together, these factors contribute to road vehicle imports being a prominent segment within Australia’s machinery and transport equipment imports.

Metalworking machinery imports are a minor component of Australia's machinery and transport equipment imports due to the country's relatively small manufacturing sector, which limits demand. The specialized nature of industries needing metalworking equipment and the machinery’s long lifespan also contribute to lower import volumes. Additionally, technological advancements in this area are slower, reducing the need for frequent upgrades and further limiting import requirements.



Analytical Analysis

I wasn't that proficient in tableau to come up with a really good visual so i just went with a **multi line chart** to analyze the analytical part of the main category imports since it's still effective in getting insights.

Graphic Techniques

I only used two colors since if I used multiple it would be hard to get insights since most of the lines were clustered together, I added a legend for the colors so people can reference and identify and made sure growth rate was percentage for better interpretability. I also added a constant line to show which sub categories were underperforming and over performing.

Trends

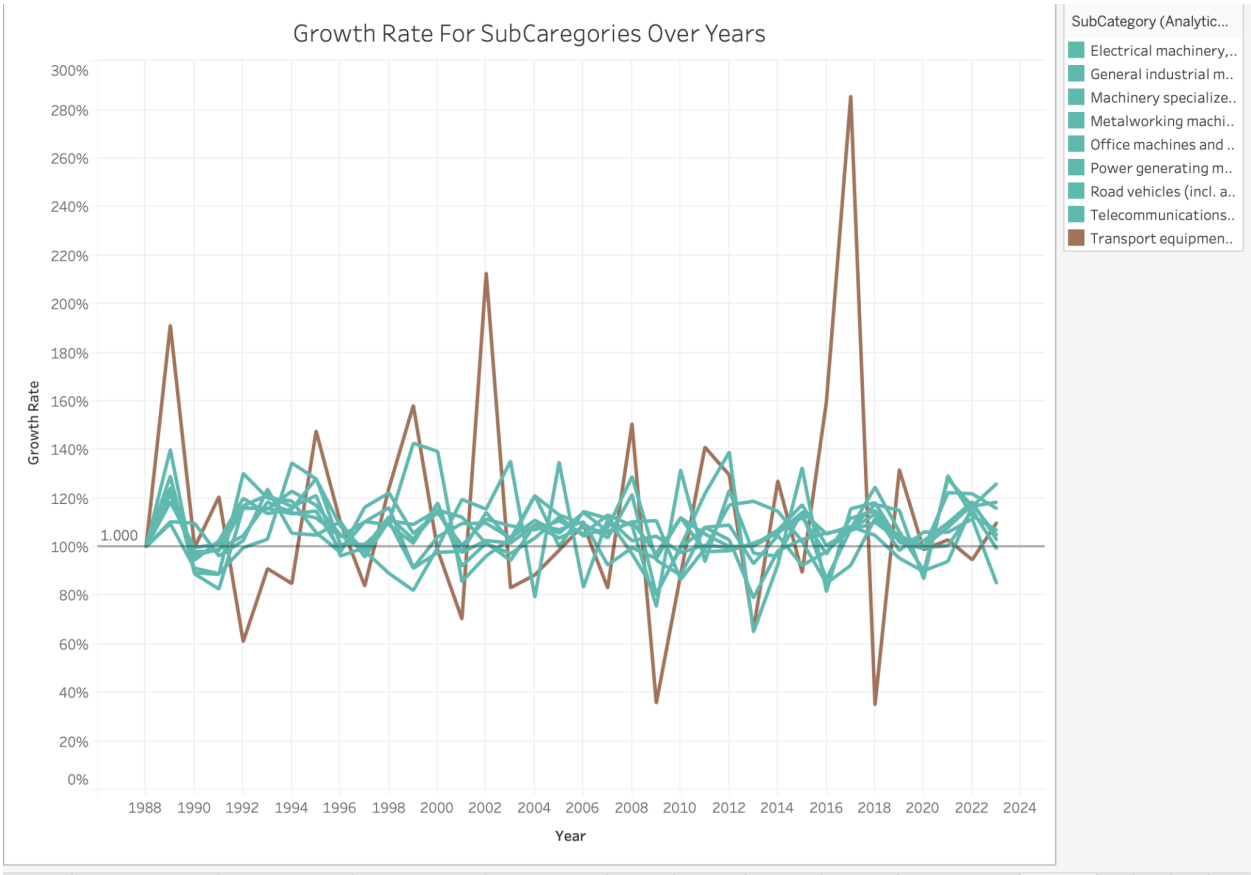
- Many subcategories move together in a similar pattern, indicating that certain external factors may be influencing multiple subcategories simultaneously.
- The majority of the subcategories exhibit relatively stable growth rates over the years, fluctuating around a baseline close to 100%

Outliers

- The **Transport Equipment** subcategory (highlighted in brown) shows several pronounced spikes, particularly around the 1989,2002 and 2017 where growth rates sharply exceed in some of those years by 200%. These spikes suggest significant growth in those years.
- The **Transport Equipment** subcategory also shows sharp declines in certain years, notably at 2009 and 2018, where the growth rate dropped well below 100%. These drops could correspond to major economic events or disruptions affecting this category specifically.

Perspective (from outside research)

The significant fluctuations in the growth rate of transport equipment imports to Australia stem from industry-specific factors. For example, the demand for transport equipment is closely tied to infrastructure projects, government investments, and private sector growth, which can vary widely year to year. Changes in the automotive industry, such as shifts toward electric and energy-efficient vehicles, can lead to increased imports of specific types of transport equipment. Moreover, regulatory standards, like emission requirements or safety protocols, can affect what types of equipment are imported and when. Supply chain considerations specific to transport equipment, such as manufacturing delays and parts shortages, can cause sudden surges or drops in imports. These industry-focused factors interact with broader economic conditions to create significant ups and downs in the growth rate of transport equipment imports to Australia.



5. Road Vehicles And Its Relationship with Manufactures of metals

My insights and visuals weren't that great here, I used statistical analysis to show the portions that were taken from the main category such as in this case machinery and transport equipment and Manufactured Goods and I used analytical analysis as a way to traverse through time to explain certain growths and declines, so in order to do this i used bar charts, pie charts and multi line charts presented in a dashboard.

Graphic Techniques

I used one color for the bar charts since they were already labeled, for the pie chart i used varying colors with a legend for reference since labeling pie charts wasn’t feasible, for the two sub categories i chose orange for road vehicles and blue for manufactures of metals and used different shades to differentiate between the statistical and analytical multi line charts, for the statistical i added three reference lines to show the key proportion points and a baseline for analytical. Overall I did the routine thing I normally do for axes and titles similar to my previous visuals, also I added a slicer for imports and exports so the user can look at both ends.

Trends

- At first glance both subcategories growth rate over time at the beginning is pretty similar for imports, but then starts deviating after 2009 and becoming out of sync. Both subcategories' proportion relative to their main categories increase over time where road vehicles reach 36% and manufacturer of metals reaches 29% which shows a correlation.
- When playing with the dashboard going through each year road vehicles always dominates in each time period in terms of it share with the main category machinery and transport equipment for imports
- At the later stages in the years for imports manufactures of metals share gets a little bigger compared to it's relative subcategories

Outliers

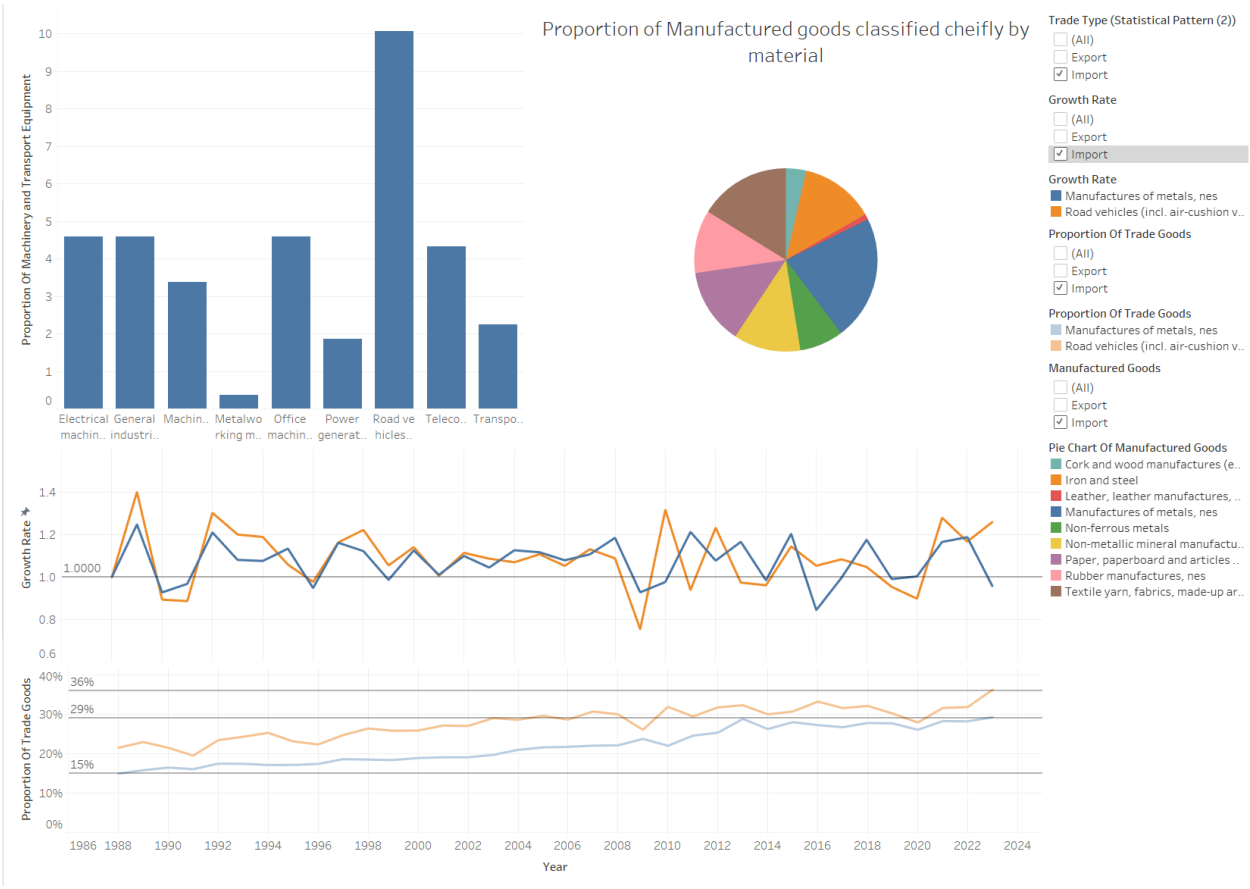
- Metalworking machinery seems to be a minority for imports when traversing the years overall in terms of share
- Cork and wood manufactures for imports is also a minority and doesn't change that much and stays small.

Perspective (from outside research)

There is a notable relationship between road vehicle imports and the imports of manufactured metal products not elsewhere specified (nes). Road vehicles require various metal components, such as body panels, engine parts, and structural elements, which are often sourced internationally. Consequently, an increase in road vehicle imports can lead to a corresponding rise in the importation of these metal products to meet manufacturing and assembly needs.

For instance, Australia's automotive industry has faced increased competition from imported products, particularly from countries like China and the United States. The fabricated metal product manufacturing sector in Australia was valued at $10.5 billion in 2021-22, with import penetration increasing by an average of 2.5% annually over the past five years, accounting for 63.4% of total demand.

This data suggests that as the importation of road vehicles grows, there is a parallel increase in the importation of metal products necessary for vehicle manufacturing and assembly, highlighting the interconnectedness of these sectors.



6. Crude rubber export analysis story

Not the best story, but it ticks the boxes for being a story I think and there's also a small preprocessing error in the analytical part that examines the growth rate spike. There should be two spikes rather than one. Overall maybe I could've benefited by adding a dashboard.

Spike in Crude Rubber (Story 1)

Here I identified a spike in the growth rate that was pretty high.for crude rubber exports.

Graphic Technique

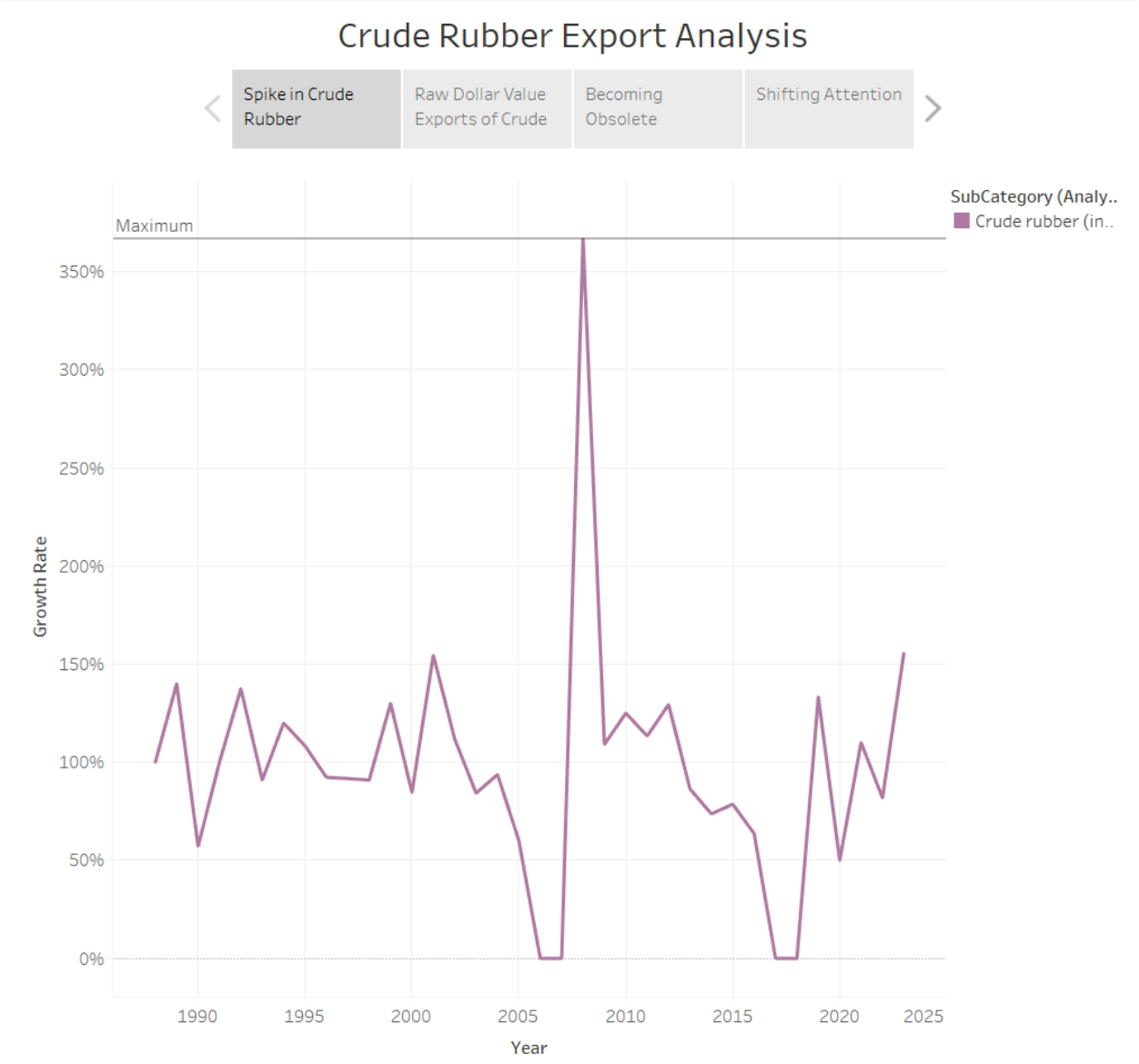
Used a reference line to emphasize the peak of the spike, so the reader know that this is unusual and should be further looked at. Percentages was appropriate here since it better highlights growth rates.

Trend

- Shows a lot of volatility with sharp declines and increases

Outliers

- The sharp spikes and zero growth are outliers



Raw Dollar Value Exports of crude (Story 2)

Here is where the small preprocessing error comes to light and the missing dollar values are shown.

Graphic technique

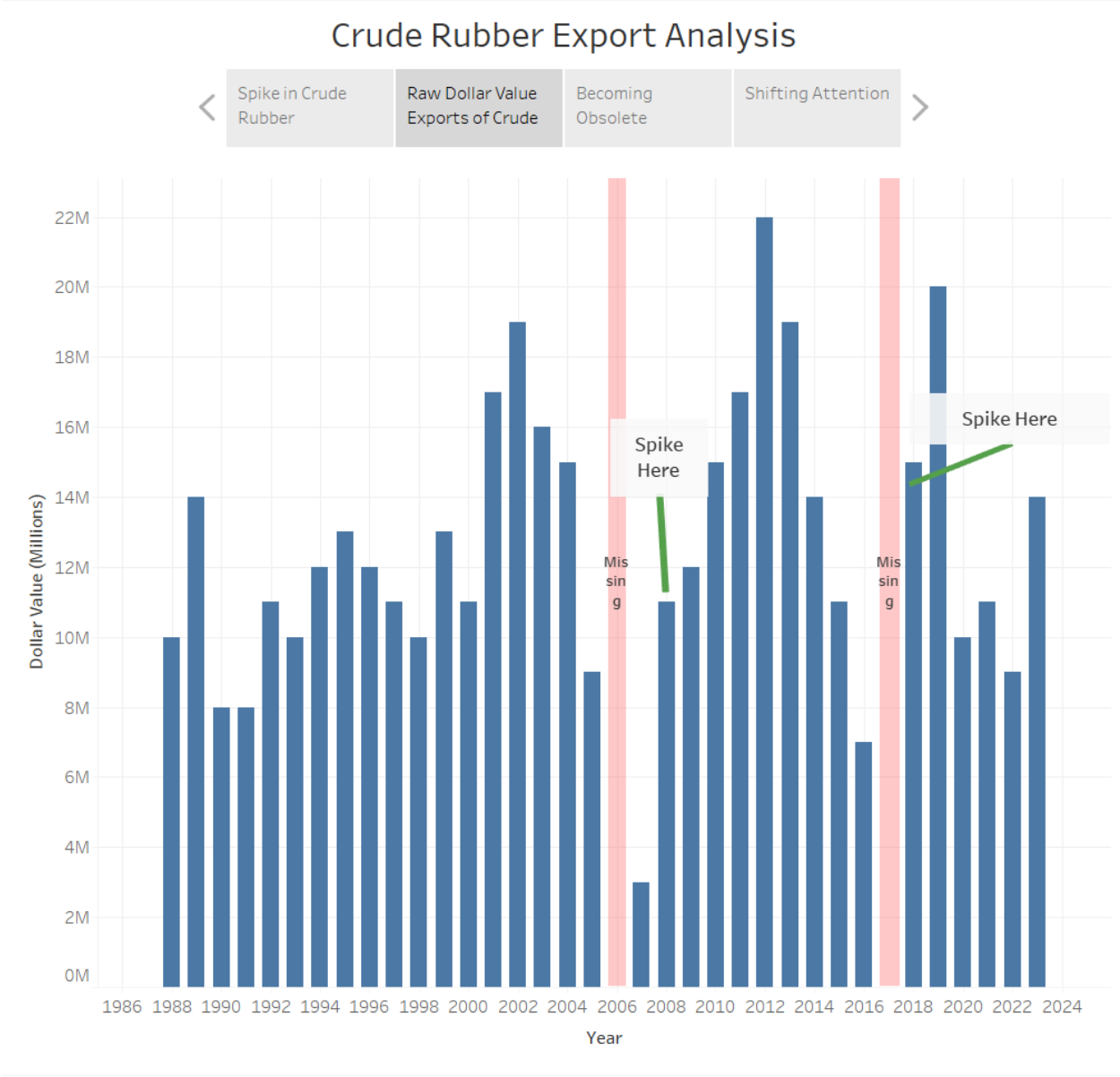
I used an area annotation in red to show the critical years that's been causing these spikes in growth rate, I used marks labeled "Spike Here" to show what the analytical chart would have looked like, but was missing.

Trend

- There isn't an exact trend, but it seems to be stable averaging 10 million dollars which is pretty small

Outlier

- Zero dollar values for years 2006 and 2017



Becoming Obsolete (Story 3)

The raw dollar values were pretty small and had negative outliers, so it's time to delve deeper and see its share against the other material.

Graphic technique

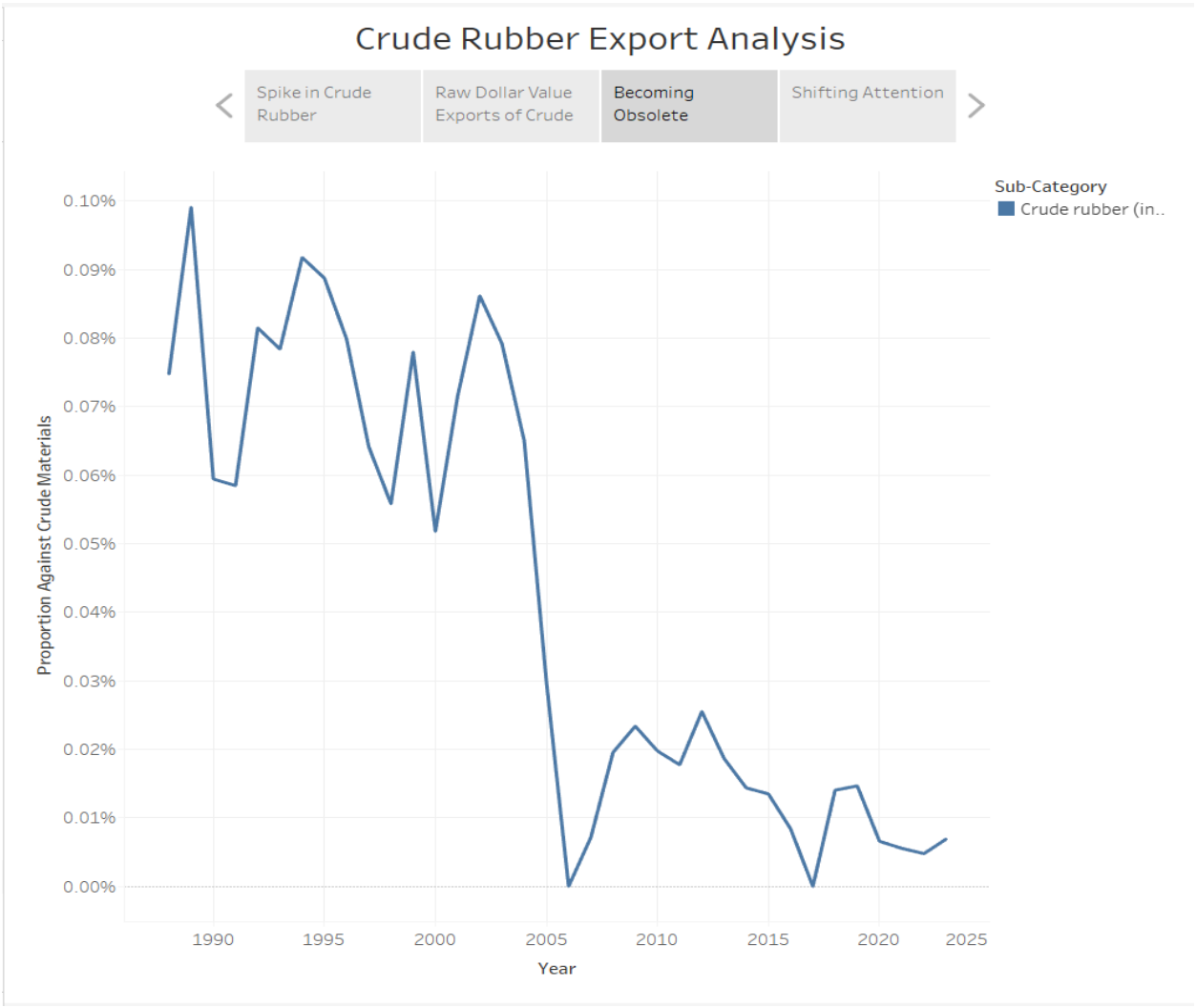
Pretty simple chart no major graphic techniques, percentages were used since they were appropriate for understanding proportions.

Trend

- It's clear that australia isn't using crude rubber anymore and is very possible that they'll stop production sooner then later
- They seem to be going on and off now with little significance in proportions

Outlier

- Years it hasn't been exported



Shifting Attention (Story End)

It's clear crude rubber is declining and is barely used, but what are the potential causes for this? This visual demonstrates some of the exports that Australia has shifted its focus to, that could be a possible explanation for one of the causes.

Graphic technique

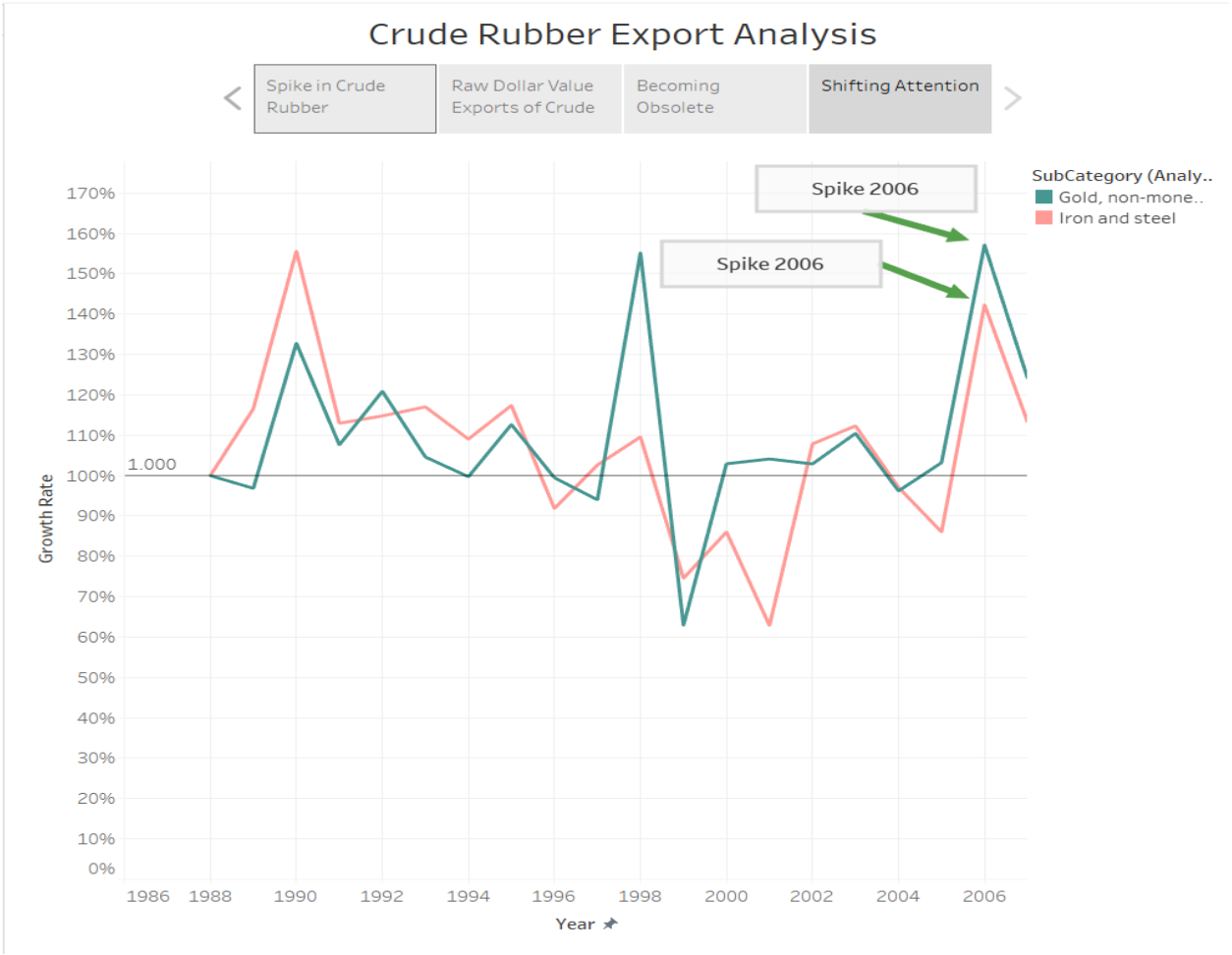
The main technique here is the marks i put for the spikes called "Spike 2006" to emphasize that when crude rubber stopped during that year these goods increased. Made a baseline for better interpretability and legend and color to distinguish the goods being shown and percentages as always. Also I only showed the time period before 2007, so the reader doesn't get distracted by the other trends.

Trend

- The goods shown are increasing over time

Outlier

- Various spikes in growth rates



Perspective (from outside research)

Australia's crude rubber exports are limited and have likely declined due to several key factors. First, the country lacks a significant natural rubber industry as its climate is unsuitable for cultivating rubber trees, leading Australia to rely on imports to meet domestic demand, with minimal surplus for export. Additionally, global market dynamics make it difficult for Australia to compete; major rubber producers like Thailand, Indonesia, and Malaysia dominate the market with larger production volumes and more competitive pricing. Moreover, domestic consumption absorbs much of the rubber available, leaving little for export. Economic factors, such as fluctuations in global demand, exchange rates, and trade policies, also impact exports, as a strong Australian dollar can make exports more costly for foreign buyers. Together, these factors contribute to Australia's limited and fluctuating crude rubber export volumes.

In 2006, Australia experienced a significant increase in exports, rising 16% to a record $210 billion. This growth was primarily driven by resource exports, including fuels and minerals, with iron ore exports increasing by 30% to $14.4 billion. Manufactured goods also saw a 13% rise, reaching $42 billion, while services exports expanded by 8% to $43.8 billion, led by education-related travel services.

The substantial growth in these sectors likely influenced Australia's trade priorities, potentially leading to a reduced emphasis on less significant export commodities like crude rubber. Given Australia's limited natural rubber production due to unsuitable climatic conditions, the country has historically relied on imports to meet domestic demand, resulting in minimal surplus for export. Consequently, the focus on more lucrative export sectors may have contributed to the decline in crude rubber exports.

7. Recommendations

1. Crude Rubber and Low Demand Sectors

- **Recommendation**: Review and potentially phase out export support for declining sectors like crude rubber, reallocating resources towards industries with higher global demand.
- **Rationale**: As Australia lacks a competitive edge in rubber production, it's beneficial to focus resources on sectors with growth potential, reducing economic inefficiencies associated with low-demand exports.

2. Machinery and Transport Equipment Imports

- **Recommendation**: Invest in domestic capabilities for machinery and transport equipment manufacturing. Government incentives for local production could decrease import dependency, especially in road vehicles and industrial machinery, reducing vulnerability to international supply chain disruptions.

- **Rationale**: Machinery and transport equipment dominate Australian imports, reflecting reliance on foreign-produced goods. Encouraging domestic production could benefit job creation and reduce trade deficits, enhancing economic resilience

3. Resource Export Industry (Iron Ore, Coal, Agricultural Products)

- **Recommendation**: Strengthen partnerships with major importers of resources, such as China and other high-demand markets. Government support through favorable trade agreements and tariff reductions can continue bolstering Australia's export growth, especially for commodities like iron ore and coal.
- **Rationale**: Australia's resource exports have seen a significant uptick, particularly post-2020, driven by global demand. Expanding strategic alliances can stabilize and potentially grow this sector further, which is critical given its economic contribution.

8. Dashboard Critics

Advantages

- In my experience with Tableau, one of its strengths is the interactivity of the dashboards. The platform's interactive elements, such as filters are particularly effective for exploring data in-depth. These features empower users to engage directly with the data, gaining insights dynamically rather than passively viewing static visuals.
- Tableau's extensions are a powerful addition that enhance its functionality, especially when standard features don't quite meet complex visualization needs. Extensions essentially act as plugins that can be added directly to dashboards, enabling advanced visuals like Sankey and Chord diagrams, which Tableau doesn't support natively. They open up Tableau's potential for sophisticated analytics and visualizations by allowing users to integrate third-party apps or custom-built tools directly into the Tableau interface.

Disadvantages

- **Limited Customization for Formatting**: While Tableau is flexible with visuals, it has limitations in terms of text formatting and some finer design elements compared to software like Power BI or custom-coded dashboards.
- with Tableau's dashboard feature, the platform is highly intuitive and accessible for creating basic analytics and visual displays. The drag-and-drop interface makes it straightforward to build dashboards that compile different charts and visuals into a cohesive view. However, when advancing to more complex analytics or custom visuals within the dashboard, the learning curve becomes more noticeable.

  Creating tailored dashboards that go beyond standard visuals often requires a deeper understanding of Tableau's full suite of tools. For example, ensuring that the dashboard

not only looks good but also remains interactive and responsive to various filters and user inputs can be challenging. This transition from creating simple dashboards to mastering intricate ones calls for additional training and time investment. Mastering advanced techniques is essential to fully unlock the potential of Tableau's dashboard capabilities and produce sophisticated, insightful visualizations that meet specific project needs.

8. Storyboard Critics

From my experience using Tableau's Story feature, there are notable pros and cons:

Advantages

- **Narrative Guidance**: It's great for creating a structured, step-by-step walkthrough of data, making it easier for audiences to follow complex insights.
- **Integration**: The ability to pull in existing dashboards and sheets allows for cohesive presentations without needing external tools.

Disadvantages

- **Limited Interactivity**: Unlike dashboards, Stories are more static, which can limit user exploration and engagement.
- **Design Flexibility**: The feature can feel restrictive in terms of layout customization, making it less visually dynamic than other options.
- **Editing Challenges**: The interface for creating and adjusting stories isn’t as intuitive, which can slow down the workflow.

Overall, Tableau's Story feature is effective for guided, narrative-driven presentations but can feel limiting for interactive and highly customized projects.