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EWI Development and Application

- **This paper introduces ANZ's Early Warning Indicator (EWI), an index constructed from financial market data that acts as an indicator of risk as perceived by market participants. The EWI identifies the occurrence of statistically significant shifts in financial market variables that would act as a warning of greater economic pressure and perceived risk. This note describes the methodology of the EWI and how it is intended to be used.¹ Going forward the EWI will be published monthly, providing timely analysis of financial market conditions in the Asian region.**
- **The EWI measures the levels and movements of financial market indicators that are believed to reflect economic vulnerability and as such derives its value by signalling when financial indicators are deemed to have shifted significantly from 'normal' levels. This information may then be used to assist in the assessment of financial and economic risk in a country.**
- **Although the results from the EWI can be used to infer perceptions of increased/decreased risk, they does not measure risk per se, nor do they forecast economic crises.**
- **This paper concludes with a practical analysis of how the EWI is interpreted and analysed. This is achieved via a contemporary example and on an historical basis with the EWI correctly signalling the onset of the Asian financial crisis in 1997.**

PURPOSE

The purpose of constructing the EWI is to develop an instrument through which financial conditions can be assessed in a timely manner. This is achieved by aggregating data from various sectors into a single indicator, thus providing a summary of financial market conditions. Such an indicator is useful to detect emerging pressures in a particular country and provides warning 'signals' when conditions change significantly. This information can then complement decision-making regarding financial exposures and assist in identifying financial risks in different countries. Although it is understood that financial markets do not always correctly interpret economic trends, they do act as a suitable proxy for risk perceptions. In addition, significant movements in financial market indicators can often have economic consequences.

This note begins by outlining the methodology used, including how the variables are chosen and the how the index is constructed. It concludes with a current and a historic example of EWI analysis in practice.

METHODOLOGY

The development of the EWI is based upon the methodologies in existing literature that construct leading indicators of financial crises.² In particular, this is centred around the work on the Index of Macroeconomic Vulnerability concept that aggregates several financial variables into a single measure. This indicator is then used to identify periods of financial vulnerability that may subsequently lead to a deterioration in a country's macroeconomic and/or financial position.

¹ The EWI develops upon the Emerging Market Vulnerability Index (EMVi) used by ANZ Country Risk.

² See Kaminsky, Lizondo and Reinhart (1998), IMF World Economic Outlook (1998), Herrera and Garcia (1999) for examples.

The models developed in the selected literature pay particular reference to the behaviour of economic and financial data in the recent Asian and Latin American crises. The motivation for developing these models, especially for Asia, stems from the fact that the Asian financial crisis in 1997 was largely unanticipated. The literature provides a useful contemporary insight into identifying key indicators of financial vulnerability in relation to the crisis that followed. With hindsight, the models employ economic and financial variables that would have indicated the danger of the impending crisis. The EWI applies some of the fundamentals of these historical models to assess contemporary risk perception in the region. An EWI is constructed for most of the countries across South East and Northern Asia, reflecting both the interests of ANZ as well as the increasingly strong trade and economic relationships that Australia and New Zealand have in the region.

The first step in construction of the EWI is the selection of variables. The majority of variables are chosen on the basis of how they have reacted historically, as demonstrated in the literature. However, the EWI builds upon these examples by employing domestic bond yields and thus adds significant information regarding financial market conditions.

VARIABLES

The EWI uses monthly times series data³, from 1997 to the current month.⁴ Six variables provide the basis of the analysis, of which four or five are selected for each country, depending upon the characteristics of particular economies. The variables are selected to encompass a broad range of sectors, each of which may give an indication as to emerging risk or risk perceptions in each country.

Crucial in the methodology of the EWI is for the data selected to move in a similar way, especially in a period of increased economic pressure or risk. Therefore the data chosen need to exhibit significant correlation with at least one or more of the other variables included in the EWI for each country.

Another key selection criteria are the timeliness and frequency of data releases, as the EWI is used as a contemporary indicator. The data used are at a monthly frequency and ideally are released with a short time lag.⁵ The variables are:

Real exchange rates versus USD (RER)

Real exchange rates are defined as the ratio of consumer prices in the home (US) and foreign countries (EWI country) multiplied by the nominal US-dollar exchange rate. An increase in this measure indicates an appreciation of the US dollar, or a depreciation of the specific EWI country. On a real exchange rate basis, an appreciation/depreciation indicates a loss/gain in competitiveness for the EWI country.

Equities market (InvEQ)

The equities market variable takes the inverse of the benchmark stock-market price index of each country. This variable infers that asset price declines result from the removal of capital from the market and therefore is an indication of an increase in perceived risk. Similarly, a rapid and prolonged equity market rally can be a precursor to an asset price bubble.

Liquidity: M2:Reserves Ratio (M2R) & Credit/GDP ratio (CR)

The M2 to foreign exchange reserves ratio variable measures the potential for pressures to emerge from a rapid conversion of local currency denominated assets into foreign currency. This may be in the context of a rapid devaluation of the local currency. This variable is primarily used for the Asian economies, whereas the EWIs for Australia and New Zealand are constructed using Credit to GDP. This variable measures private credit growth in comparison to nominal GDP; the index uses year-on-year changes in this ratio. Any rapid increase of this variable may be indicative of an increased default loss potential. Both of these variables give an indication as to the expansion of liquidity in these economies.

³ Data sources include Thomson Financial Datastream, Bloomberg and JPMorgan.

⁴ Some data series that do not begin in 1997 have been backdated by splicing the contemporary series with a comparable historic series.

⁵ Financial data is released with a short lag, however the real exchange rate and credit:GDP ratio are based on forecasts if data is not available in the current period.

Domestic currency bond yield (GBI)

The domestic currency bond yields are taken from the JPMorgan Government Bond Index (GBI) series for each country. The GBI aggregates benchmark local-currency Government bonds across varying maturities. Bond yields are considered an indicator of sovereign (default) risk and inflation expectations, as rising yields imply higher future inflation and/or risk expectations.

Foreign currency bond index (EMBI)

Similar to the GBI, the foreign currency bond yields are taken from the JPMorgan Emerging Market Bond Index (EMBI) series for each country. The yield on the EMBI gives a similar indication of risk perception as the domestic currency yields with the inclusion of the element of foreign exchange risk.

The variables used to construct each country's specific index differ as more 'developed' economies only have GBI yields, whereas 'developing' economies have both EMBI and (usually) GBI bond yields. This difference is due to the historic predominance of foreign currency bond issues out of developing economies. Also, Australia and New Zealand have credit to GDP ratios as a proxy for liquidity in place of M2:Reserves. This is due to the relatively small levels of foreign exchange reserves in these countries fluctuating significantly with central banks' liquidity management operations.

The Asian countries to which the EWI is applied and the variables included in each country's index are outlined in Table 1. The countries that an EWI can be constructed for is limited only by the availability of timely data.

Table 1. Variables in each index

	Real exchange rate	Inverse Equities	M2:Reserves ratio	Credit: GDP ratio	GBI yields	EMBI yields
Australia	X	X		X	X	
NZ	X	X		X	X	
China	X	X	X		X	X
Hong Kong	X	X	X		X	
Indonesia	X	X	X		X	X
Japan	X	X	X		X	
Korea	X	X	X		X	
Malaysia	X	X	X		X	X
Philippines	X	X	X		X	X
Singapore	X	X	X		X	X
Taiwan	X	X	X		X	X
Thailand*	X	X	X		X	

CONSTRUCTION

Each country's index is constructed by taking the sum of each normalised variable in the EWI. The normalisation process scales the data to range between historical highs and lows (the historical high being scaled to 1 and the low to 0). This process circumvents the need to assign arbitrary weights to each variable in the index, implying each variable contributes equally (i.e. has an equal weight).⁶ Therefore the EWI results for each country are measured against their own performance from 1997 onwards.⁷ The levels of the EWI are not directly comparable across countries.

It is assumed that the variables will tend to move in the same direction over time, and especially in periods of rising risk perceptions or increased financial market pressure. Therefore, due to the additive nature of the construction, this implies that an upward movement in the EWI (driven by upwards movements in

* The EMBI for Thailand was discontinued in March 2006 with component bonds (and subsequent yields) having less than 12 months to maturity.

⁶ Another method of weighting used in the literature is to apply the inverse of the standard deviation of each series, however this did not provide significantly different results to the equal weighting method in this case.

⁷ 1997 is chosen as a useful starting point that essentially scales all future data to the movements and levels observed for each series in the Asian crisis period.

its components) indicates an increase in 'vulnerability'. This key assumption has been empirically proven in various studies (IMF World Economic Outlook (1998), Herrera and Garcia (1999) amongst others) for the financial variables in the EWI. In the case of the constructed bond index yields, simple correlation analysis reveals that the GBI and/or the EMBI have significant correlation coefficients with at least one other variable in each index.

ANALYSIS

Analysis of the EWI takes place via two primary methods (demonstrated in Appendix A). The first considers deviations in the levels of the EWI, in levels, relative to its medium term trend. The second considers the volatility of the EWI.

The first analysis looks at the level of the index at the current point in time against the medium term average of the index. This variance in the movement of the EWI from its trend is assessed using a set of confidence intervals (see Chart 1 below). These intervals are estimated using the standard deviation calculated from the conditional variance of a generalised autoregressive conditional heteroskedastic model (GARCH).⁸ This method provides standard deviations that can vary over time and therefore allows the intervals to adjust to periods of extended high/low volatility. This is in preference to applying a static standard deviation that is descriptive of the entire period. Therefore the intervals will adjust for periods of time and/or countries that are characterised by high or low volatility by getting wider or narrower, respectively. The intervals themselves are constructed by adding/subtracting the first and second standard deviations around a trend that is constructed from a rolling mean.⁹ The index is expected to travel in the first interval around two-thirds of the time; this would be defined as 'normal' movement. The second interval represents where in the index travels around 95% of the time, which indicates a relatively significant fluctuation above or below the rolling mean. Breaching the second interval entirely indicates that the deviation in the index is statistically significantly different from its moving average. Therefore, where the index is travelling in relation to these intervals provides the assessment of risk perception. A movement of the EWI through the second confidence interval is considered to be a "flash" or warning signal.

The second method of analysis is a relatively short-term indicator measuring the historical volatility of the EWI over the preceding 12 months (see Chart 3). The volatility is used as a measure of the magnitude of short-term movements (regardless of direction). Higher volatility implies an increased in potential risk that is inherent in rapid and large variations in the variables.

INNOVATION

The key innovation of the EWI is to develop upon the literature of backward-looking indicators of macroeconomic pressure to construct a device to assess contemporary shifts in financial market risk perception.

In addition several enhancements to existing models have been made. In terms of variables, the addition of local and foreign currency bonds yields contributes significant information regarding the market perception of financial conditions and expectations of economic performance. Significant advances in methodology that have been adopted and developed include: the use of GARCH to construct confidence intervals over lengthy sample periods to reflect changes in levels and volatility over time; the inclusion of data from the previous regional crisis that acts as a scale when examining and comparing current performance; and using volatility analysis to complement indicator level analysis and thus adding information regarding the short-term fluctuations in the overall indicator and underlying economic variables.

⁸ The GARCH re-estimation and subsequent standard deviations are intended to take place periodically and not continually estimated contemporaneously with each EWI update. This is primarily to avoid contemporaneous shifts in variance of the EWI having undue influence on the construction of the confidence intervals.

⁹ The trend used here is a 24-month centred moving average. This is in preference the 3-year moving average used in the IMF study, which was unsuitable for the EWI as it is non-stationary. Similarly, the Hodrick-Prescott filter method that is used in some literature is not used as it can produce spurious cyclical behaviour, in addition to providing suboptimal endpoints in the data. The latter is particularly important for the EWI analysis, which is primarily focused on contemporary observations.

LIMITATIONS

Although the EWI can provide useful and timely information regarding the perception of risk in regional financial markets, it does have several limitations.

- It does not assign a "level" or rating of risk to each contemporaneous EWI observation, but rather looks at movements that may characterise movements in risk perception. Risk may be implied, as shifts in the EWI imply the market perception of potential risk, however a level or magnitude of risk is not explicitly stated.
- The state of the economic and political structures, as well as fiscal and monetary conditions, that exist in each country do not play any part in the construction of the EWI. Therefore existing relevant economic information may be omitted and perhaps only implied by the financial variables in the EWI.
- The availability of timely data that also has an adequately long historic time-series can be difficult to obtain. This is especially the case for bond yields.

GOING FORWARD

In conclusion, ANZ's EWI constructs a relatively simple method of gauging perceptions of risk in Asian financial markets and provides insight into the changing of perceptions over time. The EWI aims to provide a useful tool to detect and assess emerging risk that may represent, or indeed lead to, economic pressure.

Economics@ANZ will update the EWI on a monthly basis as economic data becomes available.

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Appendix A Contemporary Example – INDONESIA

Chart 1. EWI – Indonesia

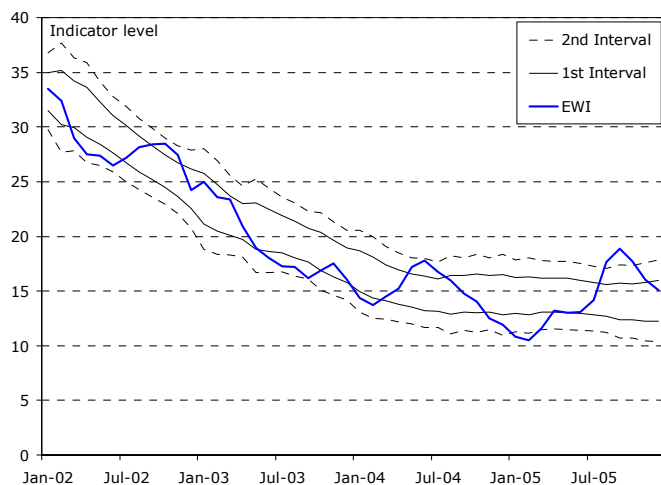


Chart 2. EWI – Components

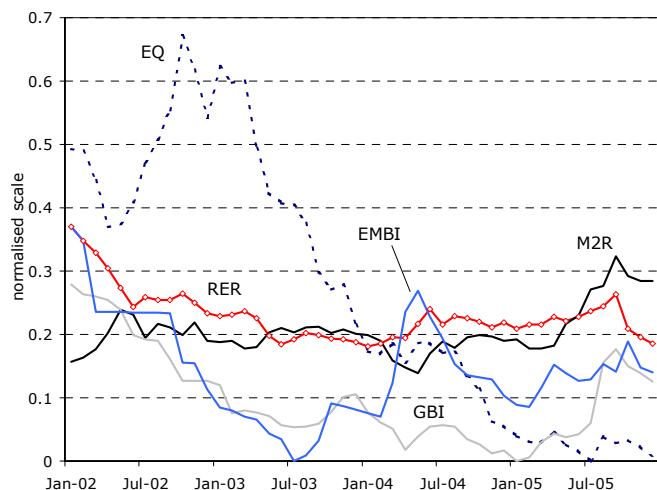
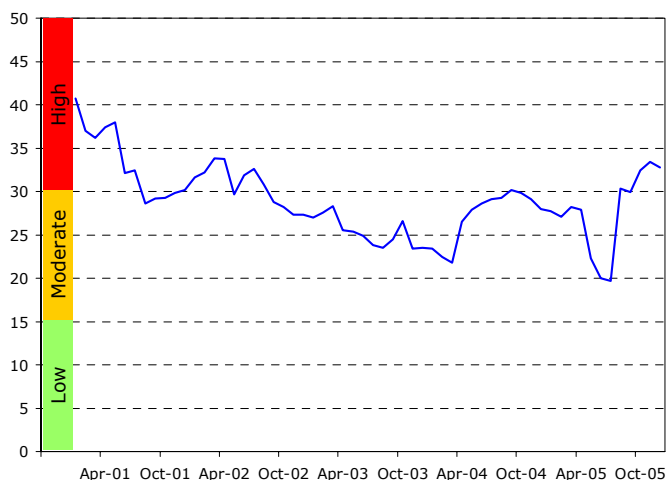


Chart 3. EWI – Volatility



- Chart 1 illustrates a contemporary EWI for Indonesia. The scale on the left-hand axis can be read as the proportion (in %) of a hypothetical highest historically possible reading.¹⁰ In this way, the level of the EWI in each country is relative to its own historical performance. However, more so than the absolute level, we are looking to analyse how the EWI travels in relation to its intervals and how it deviates from trend (the medium term average).
- The chart shows significant movements in the EWI for Indonesia in the later months of 2005 (the index is constructed to December). This period is characterised by moderate levels of volatility indicating a potential for the EWI to move relatively sharply. This is evident when the index breaches the second interval in August-September, indicating a statistically significant shift in behaviour and suggesting the emergence of increased risk perception and financial pressures. However the index then retreats to more “normal” levels by December 05. The drivers of this significant movement of the EWI can be analysed by separating the indicator into its components.
- Examining the EWI components indicates the breach of the second interval was due to an upward movement of all the economic indicators (to varying degrees). This movement was a reaction to Bank Indonesia’s initial inertia significantly to higher inflation expectations that allowed real interest rates to become negative. The real exchange rate consistently depreciated to September; the M2:Reserves ratio increased on the back of a significant drop in foreign exchange reserves, and the stock price fell. GBI yields rose sharply in response to the exchange rate depreciation, and eventually the strong monetary policy response of Bank Indonesia. The tightening of monetary policy seems to have the desired effect, with the overall index returning to a more normal level by December 05.
- Chart 3 demonstrates that the sharp rise in the EWI in August-September led to significantly higher volatility. The increase in volatility took place across all indicators but was primarily being driven by the sharp rise in GBI yields that responded to both higher inflation expectations and subsequent inflation spike, combined with the threat of a substantial depreciation of the real exchange rate.

¹⁰ That is, when every normalised variable registers its highest historical reading simultaneously, and is therefore scaled to 1, the EWI will register 100. This is not an observation that occurs in practice, it just gives the measure a historical context that compares the current observation with the history of the series.

Appendix B Historical Example Asia Crisis 1997-98 – Korea

Chart 4. EWI – Korea 1992 to June 1997

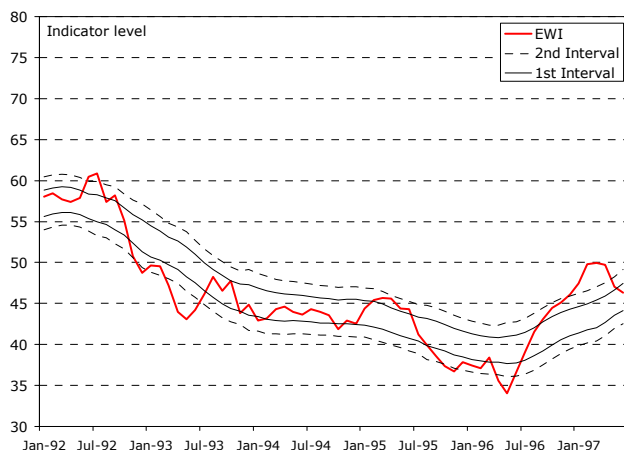


Chart 5. EWI – Korea 1992 to October 1997

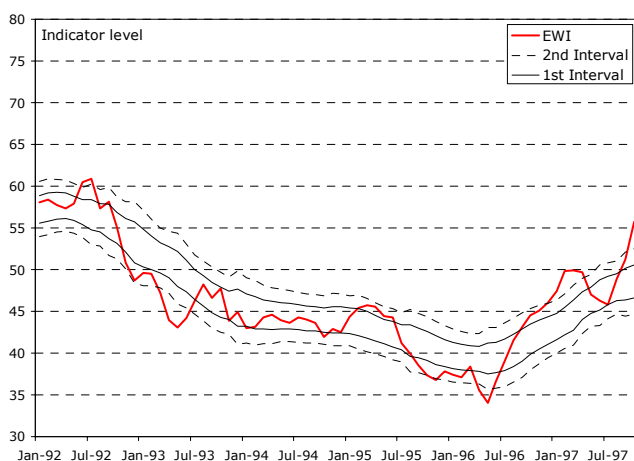
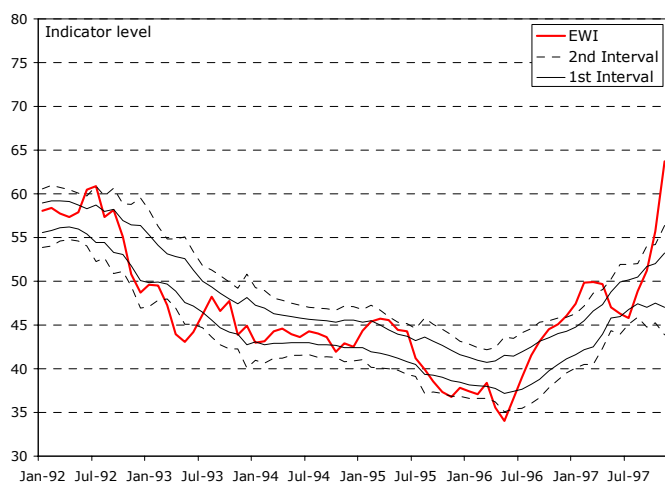


Chart 6. EWI – Korea 1992 to November 1997



- This historical analysis examines the performance of the EWI for Korea in the period leading up to and including the Asian crisis. The Korean economy in this period was characterised by large current account deficits, managed exchange rates and a banking sector burdened with mismatched foreign currency liabilities. These factors stimulated external borrowing, leaving both the financial and corporate sectors exposed to excessive foreign exchange risk.
- Chart 4 shows the EWI in the lead up to the Asian financial crisis. In October 1996, the EWI breaches the 2nd interval, indicating a statistically significant increase in pressure. An analysis of the component contributions (see Chart 8) indicates the increase in the EWI was being driven by a rise in the M2:reserves ratio. This was due to Korea depleting its holdings of foreign exchange reserves in an attempt to prop up the Won. The EWI peaks in January 1997 before the M2:reserves ratio stabilises briefly and the index begins to fall. However these fluctuations served to increase overall volatility (Chart 9) as the component volatilities of M2:reserves and bond yields in particular increased significantly.
- The EWI in Chart 5 illustrates another “flash” signalling another breach that took place in October 1997. This is again set off by an increase in the M2:reserves ratio as foreign exchange reserves fell sharply, most likely representing capital flight. With the crisis already taken hold in the region, Korea’s stock market fell sharply, which is soon followed by an equally significant depreciation of the real exchange rate and rise in bond yields. This breach occurred 2 months in advance of the onset of the crisis in Korea in December 1997. By November 1997 (Chart 6) it is clear that this combination of factors represents a significant and persistent deviation, that, unlike the breach that occurred in Chart 4, has not levelled off to then return to “normal” levels in subsequent months. From this point Moody’s downgraded Korea’s credit rating (on long term foreign currency debt) from A1 to A3, then twice more in December to Baa2 then to Ba1 as the crisis deepens. Chart 8 illustrates the depth of the crisis as all the component variables reacted in concert that causes a spike in volatility that was already at high levels (Chart 9).
- This analysis demonstrates, in this historical context, the usefulness of the EWI and the information it can provide to gauge increases in risk perception in financial markets and subsequent economic vulnerability.

Chart 7. EWI - Korea 1992 December 1997

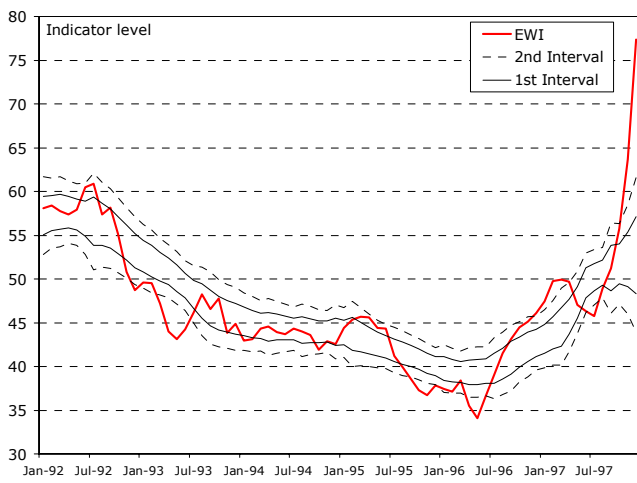


Chart 8. Components

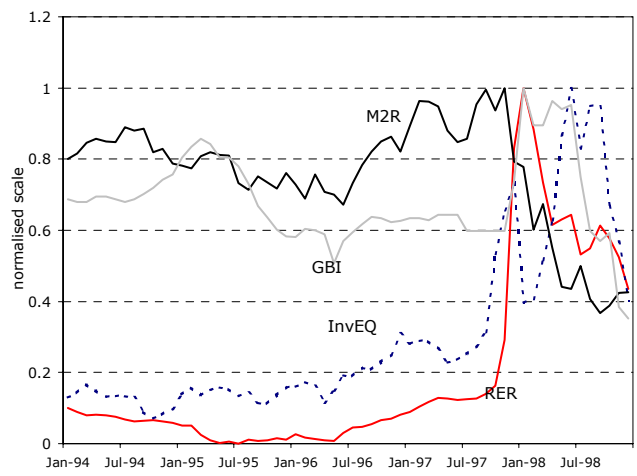
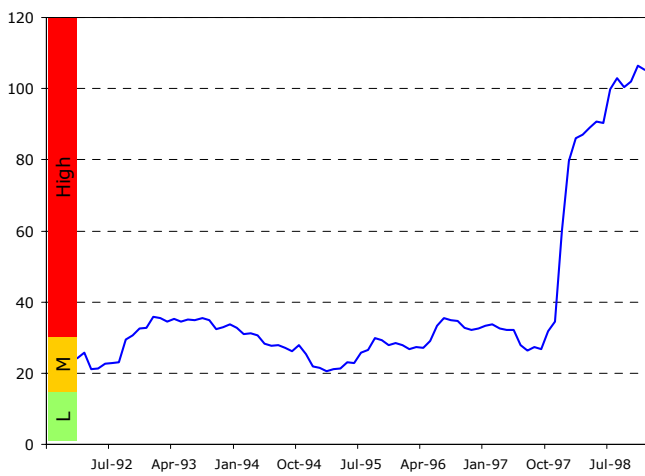


Chart 9. EWI - Volatility



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