Quantitative Portfolio Strategy
Research

Albert Desclée
+44 20 7773 3382
albert.desclee@barclays.com

Anando Maitra
+44 20 3134 0091
anando.maitra@barclays.com

Simon Polbennikov
+44 20 3134 0752
simon.polbennikov@barclays.com

Diversifying Base Currency Risk

28 January 2015

Introduction

- Many asset managers manage international portfolios relative to a sole domestic base currency
- So, currency risk typically includes:
  - Being long a diversified portfolio of foreign currencies (the numerator);
  - versus a concentrated position in a base currency (the denominator).
- But in a well-diversified global portfolio, the single largest risk is likely to be that the base currency appreciates relative to the rest of the world, devaluing the whole portfolio at once;
- Portfolio risk could perhaps be reduced by funding in a basket of base currencies
  - Reducing the idiosyncratic risk associated with the base currency
  - This is similar to diversifying across currency pairs (different numerators and denominators) as opposed to diversifying portfolio investments (numerator) only

- We explain that, while easy to implement, diversifying base currency risk:
  - can provide significant risk reduction from the perspective of most liability base currencies; and
  - can also transform the carry properties of the portfolio

- With case studies of portfolios investing in EM deposits, bonds and equities (Jan 2004 to Dec 2014)

A Case Study – Portfolio of EM 1M Deposits

- Assume a portfolio manager has an allocation to EM local currency markets:
  - FX exposure is desirable as contributing significant carry
  - Markets with significant time series of FX returns
  - Allocation unchanged over time
- From Jan 2004 to Dec 2014, this currency allocation has a volatility of 256 bp/month versus the USD:
  - Can we reduce this FX risk by taking short position in other currencies relative to the USD, ie, by diversifying the USD base currency exposure across other low-carry, developed-market, liquid currencies?
  - What are the implications on carry? And on realized returns?
  - We contrast different base currencies
  - We consider naïve, static diversification strategies as well as out-of-sample volatility-minimization
  - We consider different asset portfolios - deposits, bonds and equities

Portfolio Allocation	
BRL	8.33%
CLP	8.33%
COP	8.33%
HUF	8.33%
IDR	8.33%
ILS	8.33%
KRW	8.33%
MXP	8.33%
MYR	8.33%
PLN	8.33%
TWD	8.33%
ZAR	8.33%

Source: Barclays Research

Volatility Depends on the Base Currency

- We report volatilities of a portfolio of 12 EM 1M deposits reported in different base currencies
- Volatilities range from 143 bp/m (SGD) to 364 bp/m (JPY)
  - The SGD is managed versus a basket of major currencies
- Imperfect correlations indicate scope for diversification

Volatilities and Correlations From Various Base Perspectives (2004-2014)

Base Crcy	Vol (bp/m)	USD	EUR	GBP	JPY	CAD	AUD	CHF	SEK	SGD	NZD
USD	256										
EUR	187	0.12									
GBP	229	0.44	0.29								
JPY	364	0.65	0.21	0.29							
CAD	210	0.28	0.02	0.29	0.12						
AUD	215	-0.47	0.11	-0.04	-0.28	0.10					
CHF	238	0.16	0.66	0.21	0.38	-0.04	0.02				
SEK	215	-0.07	0.61	0.26	0.08	0.12	0.21	0.38			
SGD	143	0.78	0.23	0.38	0.72	0.16	-0.24	0.38	0.05		
NZD	267	-0.28	0.20	0.04	-0.18	-0.01	0.55	0.25	0.22	-0.15	
NOK	226	-0.03	0.49	0.26	0.02	0.25	0.22	0.28	0.65	0.03	-0.01

Source: Barclays Research

Diversifying Both Legs of Currency Exposure

- Representing a portfolio as a long-short position:
  - Long portfolio investments
  - Short base currency, or funding
- Diversifying base currency can be implemented by rolling forward FX contracts
  - Selling funding currency forward versus the original (concentrated) portfolio base currency
- In this presentation, we assume that diversification is implemented with 1M FX Forwards

Moving from Concentrated to Diversified Base Currency

Investment	BRL	CLP	COP	HUF	ILS	INR	KRW	MXN	MYR	PLN	THB	ZAR
Funding						**USD**						

Investment	BRL	CLP	COP	HUF	ILS	INR	KRW	MXN	MYR	PLN	THB	ZAR
Funding					**USD**	**EUR**	**GBP**	**JPY**				

Source: Barclays Research

BARCLAYS

Diversifying Funding Can Help Reduce Volatility

- When funding the EM 1M deposit portfolio with 50% USD and 50% EUR:
  - Volatility is reduced over 70% of the time for two-year rolling vol, except SGD;
  - Volatility no longer varies according to the reporting currency
- Returns reported in excess of domestic 1M deposit rate

Volatilities and Correlations From Various Base Perspectives (2004-2014)

Concentrated Base Currency				Equal Weighted in USD and EUR		
Base	**Vol (bp/m)**	**Avg Carry (bp/m)**	**Avg Exc. Ret. (bp/m)**	**Vol (bp/m)**	**Avg Exc. Ret. (bp/m)**	**% of time 2-yr vol is reduced**
USD	256	27	30	167	30	97%
EUR	187	30	33	170	29	77%
GBP	229	22	34	169	29	83%
JPY	364	42	56	167	30	100%
CAD	210	26	18	169	27	64%
AUD	215	2	-3	170	25	83%
CHF	238	38	23	170	28	78%
SEK	215	27	34	170	28	73%
SGD	143	32	14	168	28	21%
NZD	267	0	-10	171	26	82%
NOK	226	21	32	171	27	83%

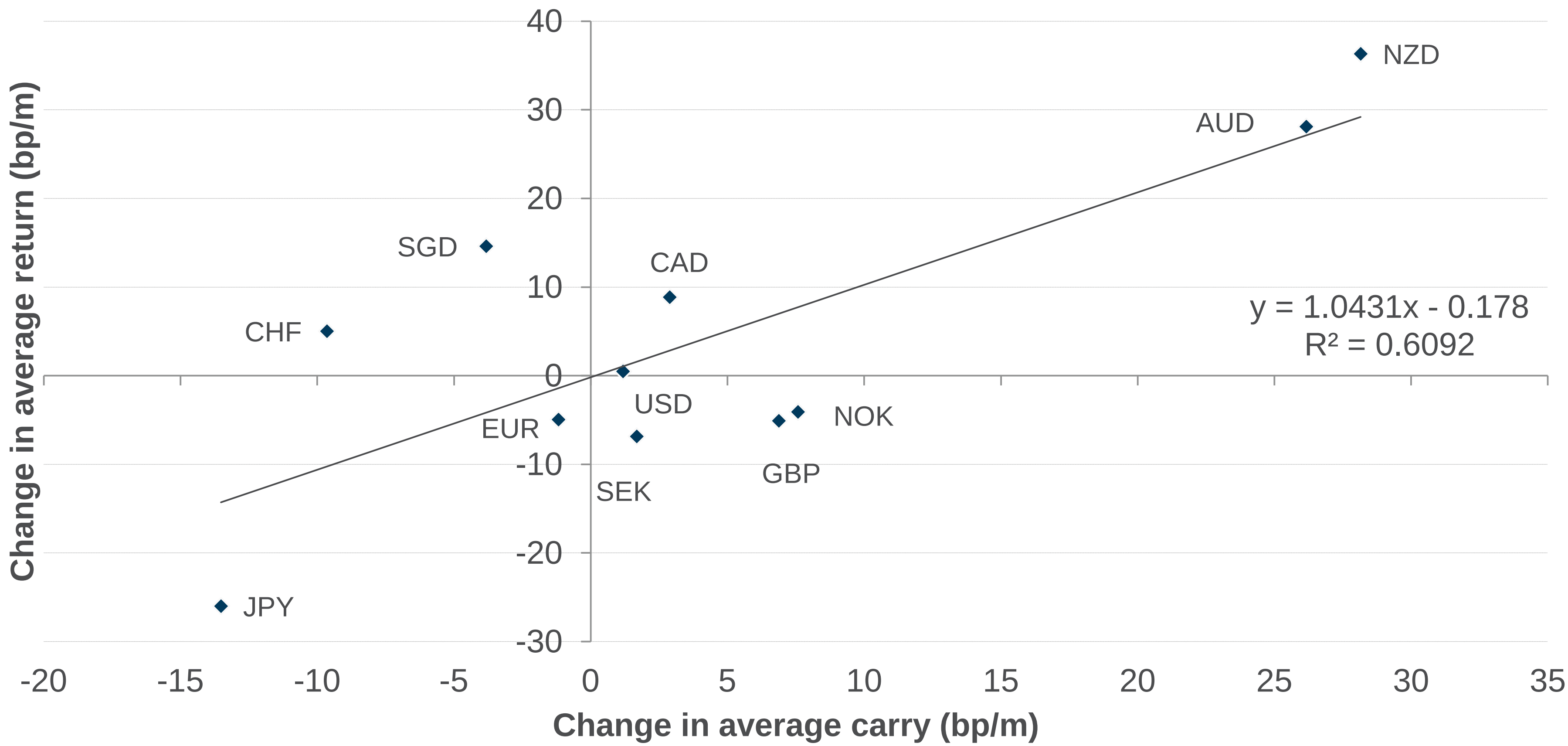
Source: Barclays Research

BARCLAYS

Diversifying Funding Can Help Improve Carry

- When shorting exposure to low yielding currencies, BC diversification can help improve carry
- For our EM deposit portfolios, changes in FX funding carry are associated with changes in realised returns

Changes in Carry vs Changes in Realised Returns (2004-2014)

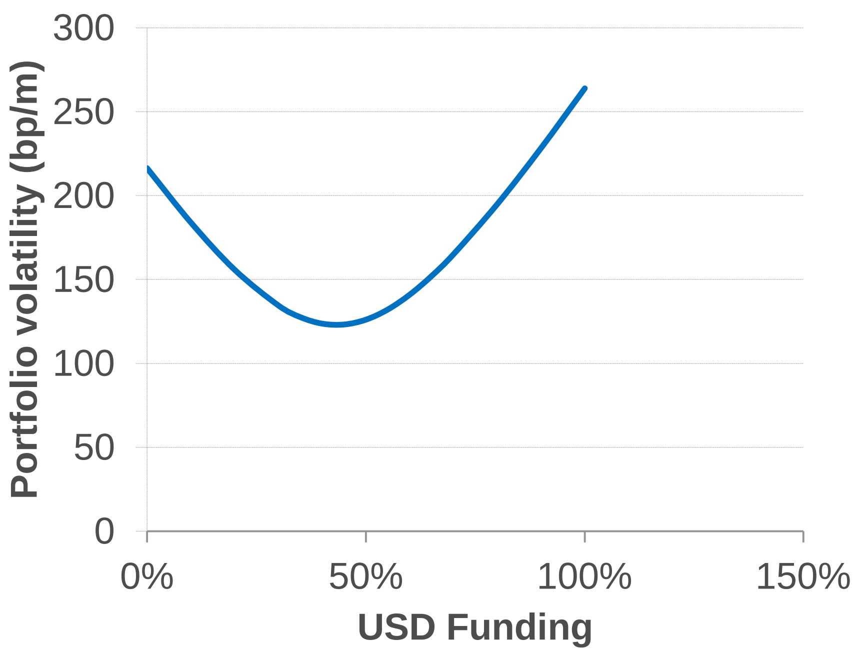


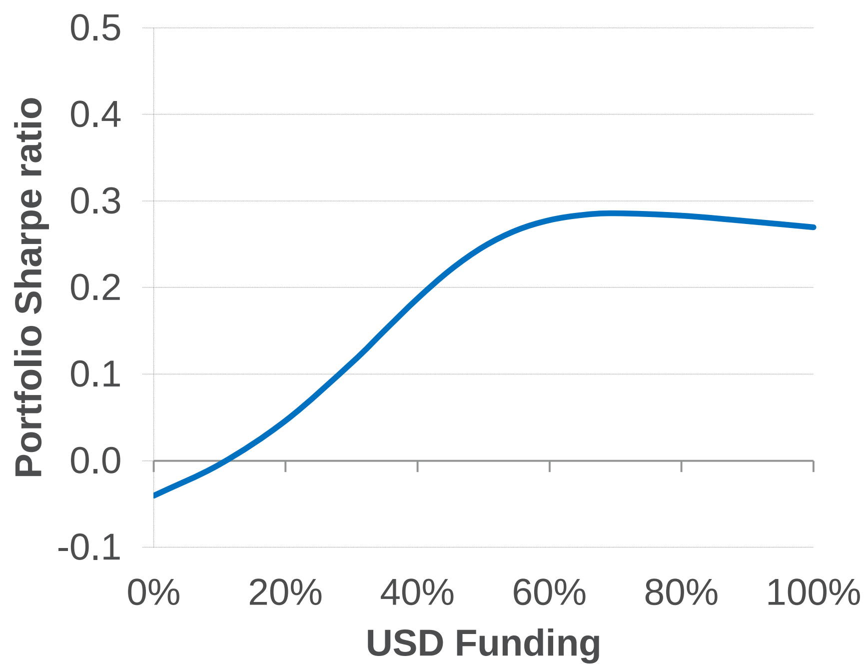
Source: Barclays Research

Diversifying Funding Can Improve Sharpe Ratio

- Diversifying funding with a low yielding and uncorrelated currency could help improve the Sharpe Ratio
- We take the perspective of an AUD-based investor diversifying funding of our example EM deposit portfolio into USD

Diversifying Funding into USD - AUD perspective (2004-2014)





Source for both charts: Barclays Research

BARCLAYS

EM Bond Portfolio

EM Bond Portfolio

- Instead of 1M deposits, we invest our equally weighted EM portfolio in 3-7y treasury bonds
- Currency volatility is much higher than bond market volatility and dominates portfolio risk

FX versus Bond Market Volatility (2004-2014)

Base Currency	Currency volatility in isolation (bp/m)	Fully FX hedged bond market volatility (bp/m)	Correlation of FX returns with bond returns	Portfolio volatility when base currency is concentrated (bp/m)
USD	256	88	37%	300
EUR	187	86	23%	223
GBP	229	90	50%	284
JPY	364	87	10%	383
CAD	210	89	10%	236
AUD	215	87	-16%	219
CHF	238	86	18%	267
SEK	215	88	21%	249
SGD	143	87	29%	187
NZD	267	88	-5%	277
NOK	226	89	22%	261

Source: Barclays Research

EM Bond Portfolio – Naive Diversification

- Our EM portfolio is now invested in 12 equally-weighted 3-7y EM treasury bond markets
- Base currency diversification can help reduce risk
  - Naïve strategy: the portfolio is fully and equally funded from USD and EUR
  - As FX risk dominates, FX diversification can benefit portfolio performance

Diversifying Bond Funding into USD and EUR (2004-2014)

Concentrated Base Currency				Equal Weighted in USD and EUR				
Base	**Vol (bp/m)**	**Avg Exc. Ret. (bp/m)**	**S.R.**	**Vol (bp/m)**	**% change in volatility**	**% of time 2-yr vol is reduced**	**Avg Exc. Ret. (bp/m)**	**S.R.**
USD	300	54	0.62	218	-28%	95%	54	0.86
EUR	223	57	0.88	220	-1%	51%	52	0.82
GBP	284	58	0.70	219	-23%	83%	53	0.83
JPY	383	80	0.72	218	-43%	100%	54	0.86
CAD	236	42	0.61	219	-7%	63%	51	0.80
AUD	219	20	0.32	220	1%	51%	48	0.76
CHF	267	47	0.61	219	-18%	73%	52	0.82
SEK	249	58	0.81	220	-11%	67%	51	0.80
SGD	187	37	0.68	218	17%	18%	52	0.82
NZD	277	13	0.16	221	-20%	68%	49	0.77
NOK	261	55	0.73	221	-15%	73%	51	0.80

Source: Barclays Research

EM Bond Portfolio – Minimizing Risk Through Diversification

- Funding basket now updated every month, based on portfolio vol-minimization in previous 36 months
  - Funding in original base currency + G4
  - Assumes that volatilities and correlations are relatively stable
- Funding diversification helped reduce realized volatility and improve Sharpe Ratio substantially in our sample

Diversifying Funding with G4 (2004-2014)

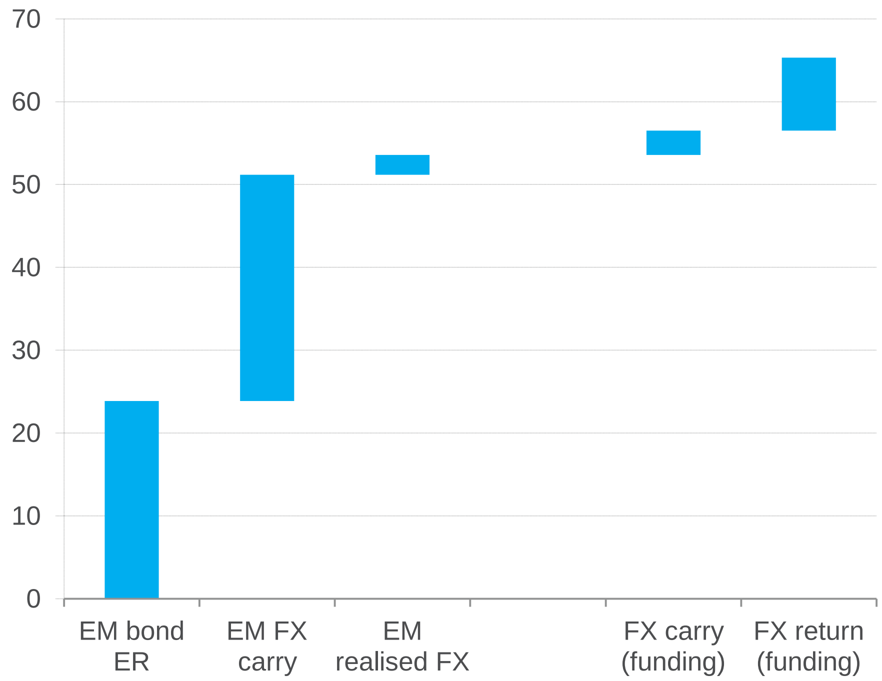
Concentrated Base Currency				Base currency minimises portfolio volatility out-of-sample using G4 currencies				
Base	Vol (bp/m)	Avg Exc. Ret. (bp/m)	S.R.	Vol (bp/m)	% change in volatility	% of time 2-yr vol is reduced	Avg Exc. Ret. (bp/m)	S.R.
USD	300	54	0.62	219	-27%	94%	65	1.03
EUR	223	57	0.88	219	-2%	75%	64	1.01
GBP	284	58	0.70	221	-22%	95%	65	1.02
JPY	383	80	0.72	219	-43%	99%	65	1.03
CAD	236	42	0.61	193	-18%	98%	57	1.03
AUD	219	20	0.32	164	-25%	99%	35	0.74
CHF	267	47	0.61	216	-19%	86%	63	1.02
SEK	249	58	0.81	219	-12%	64%	66	1.05
SGD	187	37	0.68	191	2%	48%	54	0.97
NZD	277	13	0.16	198	-28%	95%	45	0.79
NOK	261	55	0.73	221	-15%	82%	70	1.10

Source: Barclays Research

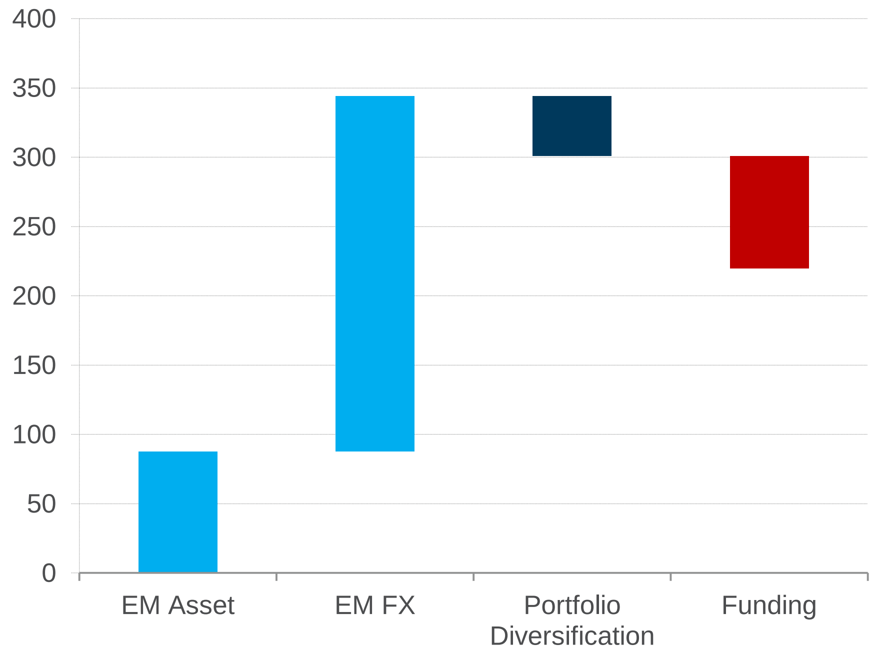
Attributing the Portfolio Effects of BC Diversification

- We continue the example from the previous page (vol-min funding diversification) and focus on the USD base portfolio (top row of previous page table)
- What was the benefit of funding diversification on portfolio return and risk?

Attributing Exc. Ret. (bp/m) – USD



Attributing Volatility (bp/m) – USD



Source for both charts: Barclays Research

Effect of BC Diversification on FX Returns

- Attribute the effects of our dynamic vol-minimization funding strategy on:
  - FX Carry and FX Spot return
- In this example Funding diversification helps better capture the EM FX premium

Effect of Funding Diversification on Performance (2004-2014)

Base	Original FX carry (bp/m)	Original FX spot return (bp/m)	Incremental FX carry (bp/m)	Incremental spot FX return (bp/m)	Incremental return (bp/m)	Reduction in Isolated FX risk	Original FX S.R.	New FX S.R.
USD	27	2	3	9	12	-36%	0.40	0.87
EUR	30	4	1	6	7	-11%	0.62	0.84
GBP	22	12	9	-2	7	-28%	0.51	0.85
JPY	42	14	-12	-3	-15	-55%	0.54	0.87
CAD	26	-7	3	13	16	-31%	0.30	0.82
AUD	2	-5	14	0	15	-43%	-0.04	0.34
CHF	38	-15	-7	24	17	-31%	0.34	0.85
SEK	27	8	3	6	8	-24%	0.56	0.91
SGD	32	-19	0	17	17	-2%	0.33	0.76
NZD	0	-11	22	11	33	-43%	-0.13	0.51
NOK	21	11	6	8	15	-27%	0.48	0.97

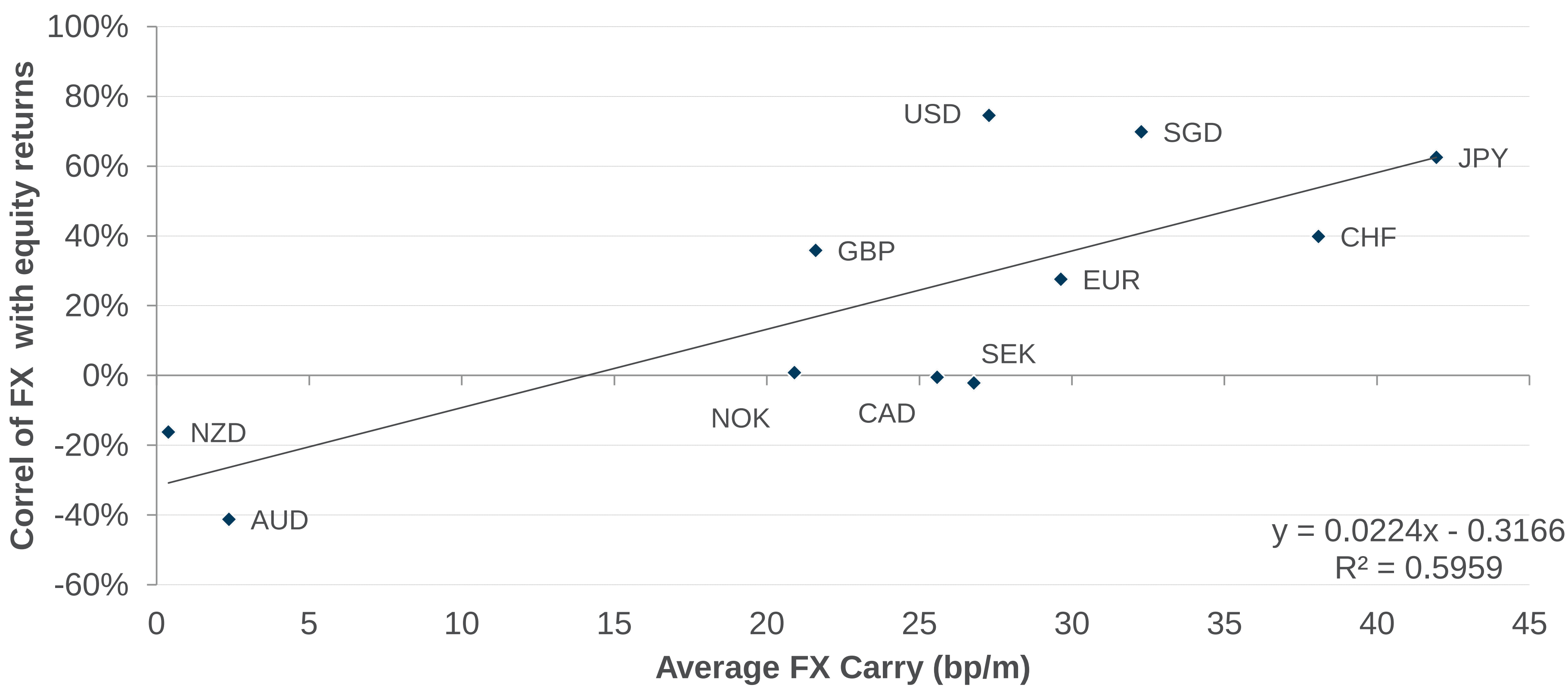
Source: Barclays Research

EM Equity Portfolio

Diversifying Funding of an EM Equity Portfolio

- Instead of deposits or bonds, the portfolio is now invested in 12 equally-weighted MSCI EM equity indices
- Equity volatility now dominates FX risk, and the carry and correlations of the funding basket with equity markets are likely to influence portfolio performance
- Managing systematic risk, and diversification between equity and EM FX premia, becomes more important than diversifying idiosyncratic FX risk

FX Carry is Related to FX Correlation with Equities (2004-2014)



Source: MSCI Equity indices, Bloomberg, Barclays Research

BARCLAYS

Diversifying Funding of an EM Equity Portfolio

- Vol-minimizing funding strategies have different effect on performance, depending on the funding universe
  - G4 => generally increase carry (and realised return in this sample)
  - Higher yielding currencies => generally decrease volatility as well as carry (and return)

Volatilities and Correlations From Various Base Perspectives (2004-2014)

Concentrated Base Currency				Base currency minimises portfolio volatility out-of-sample using G4 currencies				Base currency minimises portfolio volatility out-of-sample using CAD, AUD, SEK and NOK			
Base	**Vol (bp/m)**	**Avg Exc. Ret. (bp/m)**	**S.R.**	**Vol (bp/m)**	**% change in volatility**	**Avg Exc. Ret. (bp/m)**	**S.R.**	**Vol (bp/m)**	**% change in volatility**	**Avg Exc. Ret. (bp/m)**	**S.R.**
USD	640	82	0.44	528	-18%	95	0.62	399	-38%	46	0.40
EUR	516	80	0.53	532	3%	89	0.58	402	-22%	41	0.36
GBP	556	81	0.50	531	-4%	91	0.59	402	-28%	42	0.36
JPY	706	110	0.54	523	-26%	96	0.64	396	-44%	48	0.42
CAD	480	62	0.45	486	1%	62	0.44	402	-16%	39	0.34
AUD	399	37	0.32	403	1%	37	0.32	405	1%	39	0.33
CHF	565	71	0.44	527	-7%	90	0.59	399	-29%	43	0.38
SEK	478	78	0.56	490	2%	78	0.55	404	-16%	39	0.34
SGD	536	62	0.40	532	-1%	80	0.52	399	-26%	43	0.37
NZD	471	31	0.23	480	2%	39	0.28	407	-14%	35	0.30
NOK	492	75	0.53	507	3%	79	0.54	404	-18%	39	0.34

Source: MSCI Equity indices, Bloomberg, Barclays Research

Conclusion

- Managing an international portfolio relative to a single base currency can entail significant FX risk related to shocks in the valuation of that base currency
- Diversifying base currency exposure can help reduce risk and improve performance
  - Risk is reduced when the concentrated position in the funding currency is replaced by a diversified basket of currencies
  - Carry increases when a high-yielding funding currency is replaced by a basket of low-yielding currencies
- Base currency diversification can be implemented with a simple strategy where a basket of base currencies is sold forward vs the original funding currency
- Base currency diversification can help more efficiently capture the FX carry premium that can be embedded in international portfolios
- We have shown that in EM deposit and EM government bond portfolios risk reduction is achieved for most reporting currencies
- In equity portfolios, the scope for base currency diversification is smaller due to the small relative contribution of FX to the overall portfolio risk.
  - Nevertheless, when funding currencies are directional on equity returns, a significant risk reduction can be achieved
  - Base currency diversification may impact the allocation of systematic risk, as opposed to just diversifying idiosyncratic FX risk

Base Currency - An Analytical Explanation

An Analytical Explanation

- Assume that the return of any currencies relative to a universal "consumption basket" can be represented as a sum of systematic and idiosyncratic components:

$$\mathbf{R_i} = \mathbf{F\beta_i} + \boldsymbol{\varepsilon}_i$$

- So, if a new numeraire *j* is selected, the returns of currency *i* become:

$$\mathbf{R_i^j} = \mathbf{R_i} - \mathbf{R_j} = \mathbf{F}(\boldsymbol{\beta}_i - \boldsymbol{\beta}_j) + (\boldsymbol{\varepsilon}_i - \boldsymbol{\varepsilon}_j)$$

- And the returns of a portfolio of currencies become:

$$\mathbf{R_p^j} = \sum_{i\in I} \mathbf{w_i R_i} - \mathbf{R_j} = \mathbf{F}\left(\sum_{i\in I} \mathbf{w_i}\boldsymbol{\beta}_i - \boldsymbol{\beta}_j\right) + \left(\sum_{i\in I} \mathbf{w_i}\boldsymbol{\varepsilon}_i - \boldsymbol{\varepsilon}_j\right) = \mathbf{F}\boldsymbol{\beta}_p + \sum_{i\in I} \mathbf{w_i}\boldsymbol{\varepsilon}_i - \boldsymbol{\varepsilon}_j$$

- If the portfolio is funded from a basket of currencies as opposed to a single base currency, we have:

$$\mathbf{R_p^J} = \sum_{i\in I} \mathbf{w_i R_i} - \sum_{i\in J} \boldsymbol{\omega}_j \mathbf{R_j} = \mathbf{F}\left(\sum_{i\in I} \mathbf{w_i}\boldsymbol{\beta}_i - \sum_{i\in J} \boldsymbol{\omega}_j\boldsymbol{\beta}_j\right) + \left(\sum_{i\in I} \mathbf{w_i}\boldsymbol{\varepsilon}_i - \sum_{j\in J} \boldsymbol{\omega}_j\boldsymbol{\varepsilon}_j\right)$$

- And, in that case, portfolio variance can be written as:

$$\mathbf{V_p^J} = (\mathbf{B_p} - \mathbf{B_n})^{\mathbf{T}}\boldsymbol{\Omega}(\mathbf{B_p} - \mathbf{B_n}) + \left\{\sum_{i\in I} \mathbf{w_i^2}\boldsymbol{\sigma}_i^2 + \sum_{j\in J} \boldsymbol{\omega}_i^2\boldsymbol{\sigma}_j^2\right\}$$

Source: Barclays Research

BARCLAYS

An Analytical Explanation (continued)

- As an illustration, consider a simplified case where we have:
  - A single systematic factor underlying all currency returns
  - All currencies have a unit exposures to this systematic factor
  - Systematic and idiosyncratic volatilities are identical for all currencies
- Then, any currency returns consist of a systematic and an idiosyncratic part, both equally risky, and:

$$\mathbf{R_i} = \mathbf{f} + \boldsymbol{\varepsilon}_\mathbf{i},$$

$$\boldsymbol{\sigma}_\mathbf{i}^2 = \boldsymbol{\sigma}_\mathbf{j}^2 = \boldsymbol{\sigma}_\mathbf{f}^2 = \boldsymbol{\sigma}^2$$

- Diversifying the portfolio equally across *N* currencies, while keeping a single base currency *j*, gives the following expressions for returns and portfolio variance:

$$\mathbf{R}_\mathbf{p}^\mathbf{j} = \frac{\mathbf{1}}{\mathbf{N}}\sum_{\mathbf{i}\in\mathbf{I}} \boldsymbol{\varepsilon}_\mathbf{i} - \boldsymbol{\varepsilon}_\mathbf{j} \qquad \mathbf{V}_\mathbf{p}^\mathbf{j} = \left(\frac{\mathbf{1}}{\mathbf{N}} + \mathbf{1}\right)\boldsymbol{\sigma}^2$$

- And if the numeraire now becomes equally diversified across *m* base currencies, portfolio returns and variance become:

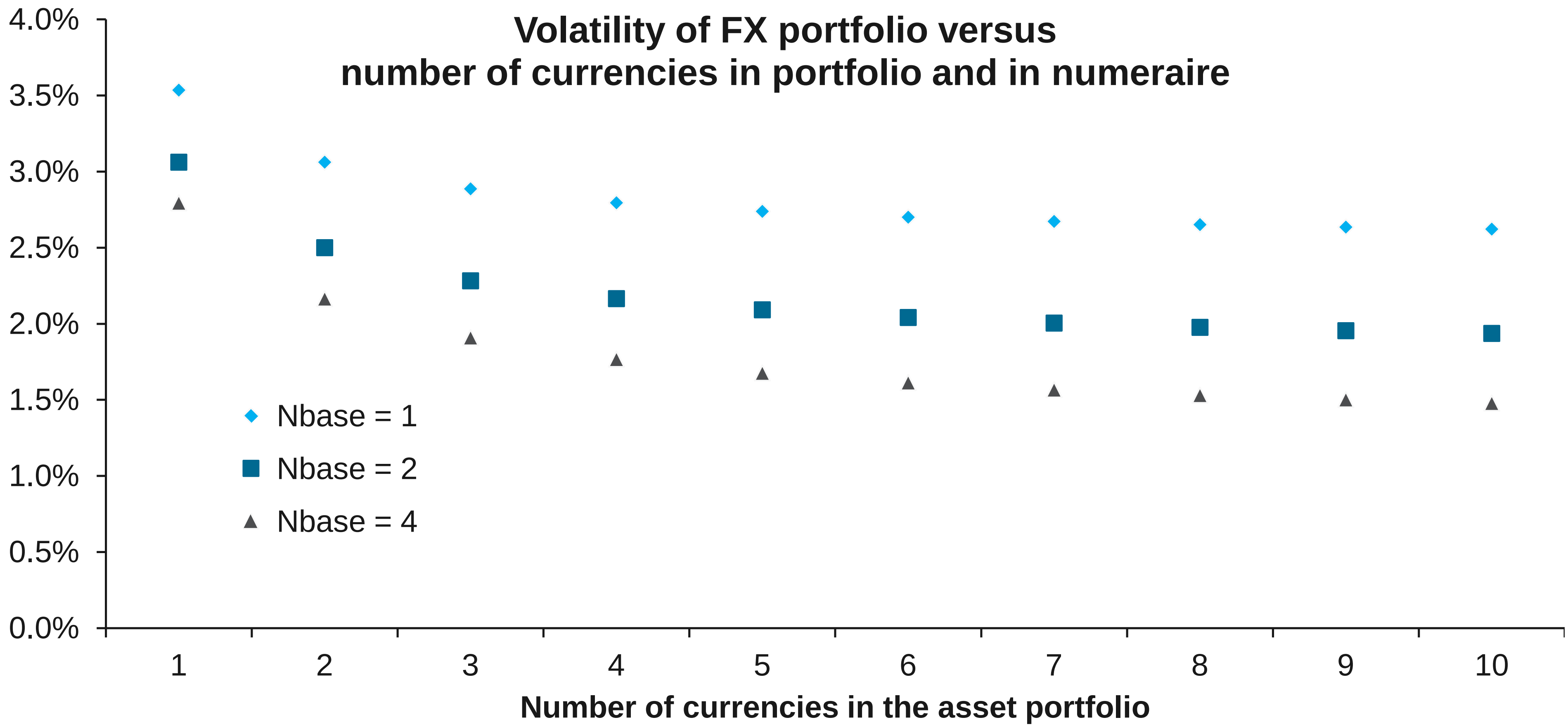
$$\mathbf{R}_\mathbf{p}^\mathbf{J} = \frac{\mathbf{1}}{\mathbf{N}}\sum_{\mathbf{i}\in\mathbf{I}} \boldsymbol{\varepsilon}_\mathbf{i} - \frac{\mathbf{1}}{\mathbf{m}}\sum_{\mathbf{j}\in\mathbf{J}} \boldsymbol{\varepsilon}_\mathbf{j} \qquad \mathbf{V}_\mathbf{p}^\mathbf{J} = \left(\frac{\mathbf{1}}{\mathbf{N}} + \frac{\mathbf{1}}{\mathbf{m}}\right)\boldsymbol{\sigma}^2$$

- Note that portfolio variance declines with the number of currencies in the numeraire basket.
  - We call this effect diversifying base currency risk

Effect of Base Currency Diversification

- Continuing the simplified case developed on the previous slide with identical volatilities, a single systematic factor and unit exposures, we can show that portfolio risk is reduced when the base currency is diversified

Portfolio risk is reduced when base currency risk is diversified



Source: Barclays Research

BARCLAYS

Analyst Certifications and Important Disclosures

Analyst Certification

We, Albert Desclée and Simon Polbennikov, hereby certify (1) that the views expressed in this research report accurately reflect our personal views about any or all of the subject securities or issuers referred to in this research report and (2) no part of our compensation was, is or will be directly or indirectly related to the specific recommendations or views expressed in this research report.

Important Disclosures:

Barclays Research is a part of the Corporate and Investment Banking division of Barclays Bank PLC and its affiliates (collectively and each individually, "Barclays"). For current important disclosures regarding companies that are the subject of this research report, please send a written request to: Barclays Research Compliance, 745 Seventh Avenue, 14th Floor, New York, NY 10019 or refer to http://publicresearch.barclays.com or call 212-526-1072.

Barclays Capital Inc. and/or one of its affiliates does and seeks to do business with companies covered in its research reports. As a result, investors should be aware that Barclays may have a conflict of interest that could affect the objectivity of this report. Barclays Capital Inc. and/or one of its affiliates regularly trades, generally deals as principal and generally provides liquidity (as market maker or otherwise) in the debt securities that are the subject of this research report (and related derivatives thereof). Barclays trading desks may have either a long and/or short position in such securities, other financial instruments and/or derivatives, which may pose a conflict with the interests of investing customers. Where permitted and subject to appropriate information barrier restrictions, Barclays fixed income research analysts regularly interact with its trading desk personnel regarding current market conditions and prices. Barclays fixed income research analysts receive compensation based on various factors including, but not limited to, the quality of their work, the overall performance of the firm (including the profitability of the investment banking department), the profitability and revenues of the Fixed Income, Currencies and Commodities Division and the potential interest of the firm's investing clients in research with respect to the asset class covered by the analyst. To the extent that any historical pricing information was obtained from Barclays trading desks, the firm makes no representation that it is accurate or complete. All levels, prices and spreads are historical and do not represent current market levels, prices or spreads, some or all of which may have changed since the publication of this document. Barclays produces various types of research including, but not limited to, fundamental analysis, equity-linked analysis, quantitative analysis, and trade ideas. Recommendations contained in one type of research may differ from recommendations contained in other types of research, whether as a result of differing time horizons, methodologies, or otherwise. Unless otherwise indicated, Barclays trade ideas are provided as of the date of this report and are subject to change without notice due to changes in prices. In order to access Barclays Statement regarding Research Dissemination Policies and Procedures, please refer to https://live.barcap.com/publiccp/RSR/nyfipubs/disclaimer/disclaimer-research-dissemination.html. In order to access Barclays Research Conflict Management Policy Statement, please refer to: https://live.barcap.com/publiccp/RSR/nyfipubs/disclaimer/disclaimer-conflict-management.html.

Disclaimer

This publication has been prepared by the Corporate and Investment Banking division of Barclays Bank PLC and/or one or more of its affiliates (collectively and each individually, "Barclays"). It has been issued by one or more Barclays legal entities within its Corporate and Investment Banking division as provided below. It is provided to our clients for information purposes only, and Barclays makes no express or implied warranties, and expressly disclaims all warranties of merchantability or fitness for a particular purpose or use with respect to any data included in this publication. Barclays will not treat unauthorized recipients of this report as its clients. Prices shown are indicative and Barclays is not offering to buy or sell or soliciting offers to buy or sell any financial instrument. Without limiting any of the foregoing and to the extent permitted by law, in no event shall Barclays, nor any affiliate, nor any of their respective officers, directors, partners, or employees have any liability for (a) any special, punitive, indirect, or consequential damages; or (b) any lost profits, lost revenue, loss of anticipated savings or loss of opportunity or other financial loss, even if notified of the possibility of such damages, arising from any use of this publication or its contents.

Other than disclosures relating to Barclays, the information contained in this publication has been obtained from sources that Barclays Research believes to be reliable, but Barclays does not represent or warrant that it is accurate or complete. Barclays is not responsible for, and makes no warranties whatsoever as to, the content of any third-party web site accessed via a hyperlink in this publication and such information is not incorporated by reference.

The views in this publication are those of the author(s) and are subject to change, and Barclays has no obligation to update its opinions or the information in this publication. The analyst recommendations in this publication reflect solely and exclusively those of the author(s), and such opinions were prepared independently of any other interests, including those of Barclays and/or its affiliates. This publication does not constitute personal investment advice or take into account the individual financial circumstances or objectives of the clients who receive it. The securities discussed herein may not be suitable for all investors. Barclays recommends that investors independently evaluate each issuer, security or instrument discussed herein and consult any independent advisors they believe necessary. The value of and income from any investment may fluctuate from day to day as a result of changes in relevant economic markets (including changes in market liquidity). The information herein is not intended to predict actual results, which may differ substantially from those reflected. Past performance is not necessarily indicative of future results.

This material has been issued and approved for distribution in the UK and European Economic Area (“EEA”) by Barclays Bank PLC. It is being made available primarily to persons who are investment professionals as that term is defined in Article 19 of the Financial Services and Markets Act 2000 (Financial Promotion) Order 2005. It is directed at, and therefore should only be relied upon by, persons who have professional experience in matters relating to investments. The investments to which it relates are available only to such persons and will be entered into only with such persons. Barclays Bank PLC is authorised by the Prudential Regulation Authority and regulated by the Financial Conduct Authority and the Prudential Regulation Authority and is a member of the London Stock Exchange.

The Corporate and Investment Banking division of Barclays undertakes U.S. securities business in the name of its wholly owned subsidiary Barclays Capital Inc., a FINRA and SIPC member. Barclays Capital Inc., a U.S. registered broker/dealer, is distributing this material in the United States and, in connection therewith accepts responsibility for its contents. Any U.S. person wishing to effect a transaction in any security discussed herein should do so only by contacting a representative of Barclays Capital Inc. in the U.S. at 745 Seventh Avenue, New York, New York 10019.

Non-U.S. persons should contact and execute transactions through a Barclays Bank PLC branch or affiliate in their home jurisdiction unless local regulations permit otherwise.

Barclays Bank PLC, Paris Branch (registered in France under Paris RCS number 381 066 281) is regulated by the Autorité des marchés financiers and the Autorité de contrôle prudentiel. Registered office 34/36 Avenue de Friedland 75008 Paris.

This material is distributed in Canada by Barclays Capital Canada Inc., a registered investment dealer and member of IIROC (www.iiroc.ca).

Subject to the conditions of this publication as set out above, the Corporate & Investment Banking Division of Absa Bank Limited, an authorised financial services provider (Registration No.: 1986/004794/06. Registered Credit Provider Reg No NCRCP7), is distributing this material in South Africa. Absa Bank Limited is regulated by the South African Reserve Bank. This publication is not, nor is it intended to be, advice as defined and/or contemplated in the (South African) Financial Advisory and Intermediary Services Act, 37 of 2002, or any other financial, investment, trading, tax, legal, accounting, retirement, actuarial or other professional advice or service whatsoever. Any South African person or entity wishing to effect a transaction in any security discussed herein should do so only by contacting a representative of the Corporate & Investment Banking Division of Absa Bank Limited in South Africa, 15 Alice Lane, Sandton, Johannesburg, Gauteng 2196. Absa Bank Limited is a member of the Barclays group.

In Japan, foreign exchange research reports are prepared and distributed by Barclays Bank PLC Tokyo Branch. Other research reports are distributed to institutional investors in Japan by Barclays Securities Japan Limited. Barclays Securities Japan Limited is a joint-stock company incorporated in Japan with registered office of 6-10-1 Roppongi, Minato-ku, Tokyo 106-6131, Japan. It is a subsidiary of Barclays Bank PLC and a registered financial instruments firm regulated by the Financial Services Agency of Japan. Registered Number: Kanto Zaimukyokucho (kinsho) No. 143.

Disclaimer (continued)

Barclays Bank PLC, Hong Kong Branch is distributing this material in Hong Kong as an authorised institution regulated by the Hong Kong Monetary Authority. Registered Office: 41/F, Cheung Kong Center, 2 Queen's Road Central, Hong Kong.

Information on securities/instruments that trade in Taiwan or written by a Taiwan-based research analyst is distributed by Barclays Capital Securities Taiwan Limited to its clients. The material on securities/instruments not traded in Taiwan is not to be construed as 'recommendation' in Taiwan. Barclays Capital Securities Taiwan Limited does not accept orders from clients to trade in such securities. This material may not be distributed to the public media or used by the public media without prior written consent of Barclays.

This material is distributed in South Korea by Barclays Capital Securities Limited, Seoul Branch.

All equity research material is distributed in India by Barclays Securities (India) Private Limited (SEBI Registration No: INB/INF 231292732 (NSE), INB/INF 011292738 (BSE) | Corporate Identification Number: U67120MH2006PTC161063 | Registered Office: 208 | Ceejay House | Dr. Annie Besant Road | Shivsagar Estate | Worli | Mumbai - 400 018 | India, Phone: + 91 22 67196363). Other research reports are distributed in India by Barclays Bank PLC, India Branch.

Barclays Bank PLC Frankfurt Branch distributes this material in Germany under the supervision of Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin).

This material is distributed in Malaysia by Barclays Capital Markets Malaysia Sdn Bhd.

This material is distributed in Brazil by Banco Barclays S.A.

This material is distributed in Mexico by Barclays Bank Mexico, S.A.

Barclays Bank PLC in the Dubai International Financial Centre (Registered No. 0060) is regulated by the Dubai Financial Services Authority (DFSA). Principal place of business in the Dubai International Financial Centre: The Gate Village, Building 4, Level 4, PO Box 506504, Dubai, United Arab Emirates. Barclays Bank PLC-DIFC Branch, may only undertake the financial services activities that fall within the scope of its existing DFSA licence. Related financial products or services are only available to Professional Clients, as defined by the Dubai Financial Services Authority.

Barclays Bank PLC in the UAE is regulated by the Central Bank of the UAE and is licensed to conduct business activities as a branch of a commercial bank incorporated outside the UAE in Dubai (Licence No.: 13/1844/2008, Registered Office: Building No. 6, Burj Dubai Business Hub, Sheikh Zayed Road, Dubai City) and Abu Dhabi (Licence No.: 13/952/2008, Registered Office: Al Jazira Towers, Hamdan Street, PO Box 2734, Abu Dhabi).

Barclays Bank PLC in the Qatar Financial Centre (Registered No. 00018) is authorised by the Qatar Financial Centre Regulatory Authority (QFCRA). Barclays Bank PLC-QFC Branch may only undertake the regulated activities that fall within the scope of its existing QFCRA licence. Principal place of business in Qatar: Qatar Financial Centre, Office 1002, 10th Floor, QFC Tower, Diplomatic Area, West Bay, PO Box 15891, Doha, Qatar. Related financial products or services are only available to Business Customers as defined by the Qatar Financial Centre Regulatory Authority.

This material is distributed in the UAE (including the Dubai International Financial Centre) and Qatar by Barclays Bank PLC.

This material is distributed in Saudi Arabia by Barclays Saudi Arabia ('BSA'). It is not the intention of the publication to be used or deemed as recommendation, option or advice for any action(s) that may take place in future. Barclays Saudi Arabia is a Closed Joint Stock Company, (CMA License No. 09141-37). Registered office Al Faisaliah Tower, Level 18, Riyadh 11311, Kingdom of Saudi Arabia. Authorised and regulated by the Capital Market Authority, Commercial Registration Number: 1010283024.

This material is distributed in Russia by OOO Barclays Capital, affiliated company of Barclays Bank PLC, registered and regulated in Russia by the FSFM. Broker License #177-11850-100000; Dealer License #177-11855-010000. Registered address in Russia: 125047 Moscow, 1st Tverskaya-Yamskaya str. 21.

This material is distributed in Singapore by the Singapore branch of Barclays Bank PLC, a bank licensed in Singapore by the Monetary Authority of Singapore. For matters in connection with this report, recipients in Singapore may contact the Singapore branch of Barclays Bank PLC, whose registered address is One Raffles Quay Level 28, South Tower, Singapore 048583.

Barclays Bank PLC, Australia Branch (ARBN 062 449 585, AFSL 246617) is distributing this material in Australia. It is directed at 'wholesale clients' as defined by Australian Corporations Act 2001.

IRS Circular 230 Prepared Materials Disclaimer: Barclays does not provide tax advice and nothing contained herein should be construed to be tax advice. Please be advised that any discussion of U.S. tax matters contained herein (including any attachments) (i) is not intended or written to be used, and cannot be used, by you for the purpose of avoiding U.S. tax-related penalties; and (ii) was written to support the promotion or marketing of the transactions or other matters addressed herein. Accordingly, you should seek advice based on your particular circumstances from an independent tax advisor.