https://doi.org/10.1016/j.annals.2017.07.019

MODELLING THE INTERDEPENDENCE OF TOURISM DEMAND:

The Global Vector Autoregressive Approach

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Acknowledgement: Authors would like to acknowledge the finical support of the Hong Kong Research Grants Council (Grant No. PolyU 5475/12H).

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Abstract

This study develops a global vector autoregressive (global VAR or GAR) model to quantify the cross-country co-movements of tourism demand and simulate the impulse responses of shocks to the Chinese economy. The GVAR model overcomes the endogeneity and over-parameterisation issues found in many tourism demand models. The estimation results show the size of co-movements in tourism demand across 24 major countries in different regions of the world. In the event of negative shocks to China's real income and China's tourism price variable, almost all of these countries would face fluctuations in their international tourism demand and in their own prices in the short run. In the long run, developing countries and China's neighbouring countries would tend to be more negatively affected than developed countries.

Keywords: *Tourism Demand*, *Co-movement*, *Economic Interdependence*, *Global VAR*, *Impulse Response*

INTRODUCTION

International tourism is one of the most important economic activities in an open economy. It enables a country or region to earn substantial foreign exchange, generate employment for local residents and stimulate local economic growth. Thus, the United Nations World Tourism Organization (UNWTO) constantly describes tourism as the key to development, prosperity and well-being (UNWTO, 2013, 2014, 2015). Many key players in international tourism are both top destinations and top source markets, for example, Australia, China, France, Germany, Italy, the UK and the USA. Not surprisingly, the key players are also major world economies, demonstrating the close ties between tourism and economic development. Geographically, the key players are not limited to a single region; they are widely spread across different continents and include not only developed countries in Europe, but also emerging economies such as China and Russia. Hence, engagement in international tourism activities is a global phenomenon.

The modern global economy is characterised by interdependence, which denotes a reciprocal relationship above a certain level of integration between two or more countries. When cross-country interdependence reaches a certain level, as noted by Panić (2003, 8), 'what happens in one group of economies may have a major impact on another group – even when the volume of direct trade between the two is small – through the effect on a third group with which both these groups trade heavily'. International tourism facilitates cross-country connections and integration, as it involves the trading of goods and services, the flow of foreign exchange and the movement of people. As a result, co-movements of macroeconomic performance and international tourism demand can be observed across countries.

Take, for example, the recent global recession triggered in 2008 by a subprime mortgage crisis in the USA. This recession demonstrates how a country-specific event can have global implications. According to the UNWTO, international tourism started to decline during the second quarter of 2008, and arrivals plummeted by 8% between January and April 2009; the decline was confirmed by a similar drop in worldwide passenger traffic (Papatheodorou, Rosselló, & Xiao, 2010; Smeral, 2010). On the financial front, economic activities in many countries remained subdued by the credit crunch, which restricted the expansion capacity of tourism firms. The world labour market also suffered a downturn, with the worldwide unemployment rate estimated at between 6.5% and 7.4% in 2009 (Papatheodorou et al., 2010).

Given the interdependent nature of the global economy, tourism firms in all destinations are now operating in an increasingly challenging environment. On the demand side, they face highly diverse tourists from different source markets; on the supply side, they encounter fierce competition from neighbouring destinations and further afield from multinational corporations such as hotel chains and airlines that have a physical presence in various locations. As a result, tourism firms are constantly susceptible to a broad range of uncertainties at home and abroad.

Therefore, it is of practical importance to measure the interdependence of tourism demand across countries, so that practitioners can gauge the effect of the external environment and the effect of distant events on their home market. However, quantitative studies of tourism demand tend to focus on the dependent nature of a single origin-destination pair, leaving out the spillover effects on other countries. From the perspective of tourism demand modelling, this limitation is a result of the lack of appropriate econometric models to account for the endogeneity among the variables of a large number of countries. Currently, no quantitative studies have analysed the interdependence of tourism demand across the major countries in the world or simulated the effect of a country-specific shock on tourism demand of other major countries.

This study develops a tourism demand model using an innovative approach called the global vector autoregressive (global VAR, or GVAR) model, which was first introduced by Pesaran, Schuermann and Weiner (2004) to measure the interdependence of tourism demand in terms of contemporaneous impact elasticities. Recognising China's ascending status in the global economy, this study further examines the effect of shocks to the Chinese economy and simulates the subsequent disruptions to China's top tourism partners.

This study makes several contributions. It represents an initial attempt within tourism research to study the interdependence of international tourism demand at a global level, which is a research direction worthy of greater attention. Methodologically, the study expands tourism demand modelling studies by introducing an innovative system-of-equations technique that overcomes the over-parameterisation issue that can occur when accommodating a large set of endogenous variables in a model.

The rest of the paper is organised as follows. Section 2 provides the theoretical foundation for understanding the interdependence of tourism demand. Section 3 discusses the limitations of common tourism demand models. Section 4 describes the global VAR approach. Section 5 presents the model estimation results, and Section 6 concludes the study.

ECONOMIC INTERDEPENDENCE OF TOURISM DEMAND

As a major form of trade, international tourism raises or lowers a country's dependence on other countries and is particularly important to developing countries (Jafari, Baretje, & Buhalis, 2000; Stabler, Papatheodorou, & Sinclair, 2010). The economic leakages caused by the outbound tourism demand of residents from developed countries often create a trade deficit in the balance of payments of those countries. Meanwhile, many developing countries receive net monetary inflows as a result of diversifying their industries into tourism or attempting to gain additional tourism receipts by attracting more tourists from abroad (Stabler et al., 2010). Admittedly, a country's trade balance is related to not only tourism demand, but also the trading of other goods and services. For example, tourism-related businesses may rely on imports and receive foreign direct investment as their input factors.

The current study focuses only on the demand side of the tourism sector. The following sections review the reasons for the interdependence of tourism demand across countries globally, and note that one of the implications of interdependence is the co-movement of tourism demand, or more formally the synchronisation of business cycles.

2.1 Interdependence and spillover effects

From the perspective of a given country, its economic interdependence on the rest of the world is a measure of how much it *depends on* and *is depended on by* other countries. This can be determined by comparing the country's inbound tourism demand with its outbound tourism demand. That developed countries are more likely to register a trade deficit on their tourism account and developing countries tend to have a trade surplus on the same account indicates how important the tourism sector is to developing countries (Jafari et al., 2000; Stabler et al., 2010).

A country's inbound tourism is linked to the economic situations of other countries and has profound effects on the country's local economy. Briefly, the spending by inbound tourists brings income directly to tourism-related businesses and supports jobs within those businesses. Through the backward links between industries and the re-spending of income, the direct economic effect (i.e., initial tourist spending) is multiplied, creating indirect and induced effects on non-tourism businesses (Stabler et al., 2010). Over time, the injection of tourism income into the local economy elevates the income level of local people and stimulates economic growth. The causal relationship between inbound tourism and local economic growth has been empirically tested, usually under the tourism-led-growth (TLG) hypothesis (see Brida, Cortes-Jimenez, & Pulina, 2016 for a review). As inbound tourism demand is primarily influenced by economic factors in the source countries, a country's tourism sector and even its macroeconomic performance inevitably depend on the external macroeconomic environment, i.e., the worldwide co-movements of economic factors, or more formally the synchronisation of business cycles.

From the perspective of a source market, a country's outbound tourism is a channel through which the country affects other countries. A shock to the source market can have spillover effects on foreign economies. For example, a temporary adverse shock to the source market's GDP or its exchange rates may lead to a contraction in tourist outflows (Webber, 2001). As a result, the destination countries will suffer from a decline in the number of inbound tourists and consequently a decline in tourism income. Over the long run, businesses in the destination and other countries may be indirectly affected by the shock, either because they are part of the highly integrated supply chain of international tourism or because of the reduced re-spending of tourism income. Schubert and Brida (2009) use a dynamic macroeconomic equilibrium model to show the welfare-decreasing mechanism of a temporary shock. However, it is worth noting that the spillover effects on foreign economies should not be over emphasised, especially in the context of small economies.

Interdependence can also be explained by the complementary or substitutive relations between destinations. Complementary relations may occur when several countries are bundled in a holiday package. In other cases, several countries may adopt a common visa policy and abolish border controls at their shared borders, for example, the Schengen Area in Europe. Alternatively, the relationship between destinations may contain elements of competition, especially if they are perceived as substitutes. For example, the islands in both Spain and Greece are popular destinations for summer holidays and are therefore substitutes for each other. In such complementary/substitutive relations, the tourism demand for one destination correlates with that for the other. From an economic perspective, the sign of the cross-price elasticity (+ or -) between two destinations indicates the nature of their relation (e.g., Dwyer, Forsyth, & Dwyer, 2010; Li et al., 2013; Li et al., 2006; Mangion, Durbarry, & Sinclair, 2005). The complementary/substitutive relations between destinations may be associated with a wide range of factors such as climate, geographical proximity, cultural similarity, destination attractions/facilities, and political reasons (e.g., visa policies), which together explain the interdependence between tourism countries. A change in one factor (e.g., a terrorist event) in one country may affect tourism demand in not only that country but also other countries, either positively or negatively depending on their relations (i.e., complementary/substitutive).

2.2 Business cycle synchronisation

As a result of interdependence, it is possible to observe co-movements between international tourism demand and the synchronisation of business cycles in countries around the world. Two main hypotheses explain business cycle synchronisation (Bagliano & Morana, 2010; Sayek & Selover, 2002; Selover, 1999). The first is the locomotive hypothesis, which assumes that idiosyncratic business cycles are transmitted across countries via trade flows, capital movements, labour migration, and technological transfer. Under this hypothesis, are income, prices and interest rates are usually prone to idiosyncratic shocks (Sayek & Selover, 2002). The second is the common shocks hypothesis, which considers shocks that affect the majority of countries at the same time, such as technological advances or commodity supply shocks (e.g., the oil crisis in the 1970s).

Many studies have attempted to empirically test mechanisms for business cycle synchronisation under labels such as the international transmission mechanism, decoupling and recoupling and international contagion (e.g., Artis, Fidrmuc, & Scharler, 2008; Canova & Ciccarelli, 2012; Hamori, 2000; Sayek & Selover, 2002). Using a sample of 106 countries over the 1960–2008 period, Kose, Otrok and Prasad (2012) find a substantial convergence of business cycles *among industrial economies* and *among emerging market economies*, but a concomitant divergence (or decoupling) of business cycles *between* these two groups of countries.

The number of studies of the business cycles of tourism demand is limited, although the earliest studies were conducted in the late 1970s (Schulmeister, 1979). These studies either track the general business cycles of a specific country’s tourism sector (e.g., Frechtling, 1982; Guizzardi & Mazzocchi, 2010) or examine how tourism demand elasticities evolve across different phases of a business cycle (e.g., Smeral, 2012). However, few studies have quantified the magnitude of interdependence of tourism demand for different destinations.

An emerging trend since the recent global financial crisis is that developing countries are playing an increasingly important role in the global economy (Papatheodorou et al., 2010).

Indeed, outbound tourism from developing countries helps to restore the reciprocity and stability of international trade. For example, over the past two decades, China has shown the fastest growth in international tourism spending thanks to its rising disposable income, relaxation of restrictions on foreign travel and appreciating currency (UNWTO, 2015). In 2009, when the global economy was severely hit by the financial crisis, China's international tourism spending registered an impressive 21% increase, whereas other top spenders saw near zero or even negative growth (UNWTO, 2010). Therefore, although the studies discussed at the beginning of this section suggest that developing countries are dependent on developed countries for a trade surplus, it is equally plausible that developed countries are now increasingly reliant on developing countries for stable revenue in their tourism sectors.

MODELLING INTERDEPENDENCE

Tourism demand analysis uses econometric models to quantify the effects of various factors on tourism demand. To model the interdependence across countries, an econometric model has to simultaneously accommodate a large number of variables and treat them as endogenous, which may violate the assumptions of many current econometric models. Vector autoregressive (VAR) models are a type of system-of-equations model designed to address the endogeneity issue (Li, Song, & Witt, 2005), and they have been applied in tourism research. Hence, they are particularly suitable for modelling interdependence.

3.1 The endogeneity issue

As discussed in Section 2, economic interdependence means the cross-country co-movement of tourism demand and its economic determinants. Modelling interdependence requires collecting the tourism demand and economic variables for a number of countries within a single demand system, in which all of the variables are treated as endogenously decided.

One problem with the econometric models often used in tourism demand research, especially the single-equation models, is that they impose the assumption of *exogeneity* on the explanatory variables. These models include the autoregressive distributed lag model (ADLM), error correction model (ECM) and almost ideal demand system (AIDS) (see Wu, Song, & Shen, 2017 for a review of econometric models). Any randomness in the data-generating process (DGP) of the explanatory variables is independent of the error term in the DGP of the dependent variable (Davidson & Mackinnon, 2003). Stock and Watson (2012) summarise three situations in which the assumption of exogeneity is violated in modelling practice, including omitted variables, measurement errors in the regressors and simultaneous causality, the last of which is closely related to interdependence.

Within a causal relationship, simultaneous causality is a situation in which the causality runs not only from the explanatory variables to the dependent variable (i.e., X_i causes Y_i), but also in the reverse direction (i.e., Y_i causes X_i). In the context of tourism demand modelling, where the variation in tourism demand is explained by a variation in economic factors in both a source country and a destination country, simultaneous causality means that any variation in tourism demand can in turn affect the economic factors. It is not uncommon to see that an influx of tourists causes demand pressure on a destination's economy. For example, based on the data for 45 European cities, Albalate and Bel (2010) find that the additional demand for public transport by tourists imposes external costs on local residents because it causes congestion due to a supply constraint, although tourism income may provide some funding for the transport services. In the same vein, the demand pressure can indeed affect a wider range of products and ultimately cause inflation in the local economy. In contrast, the residents of the destination may go on outbound trips, creating spillover to the foreign countries they are visiting. At the global level, such spillover can take place across open economies and shape the interdependent nature of the global economy. Hence, modelling the interdependence across countries requires treating the tourism demand variables and economic variables as endogenous, a violation of the exogeneity assumption.

3.2 Vector autoregressive (VAR) models

VAR models are system-of-equations models that relax the assumption of exogeneity. Back in the 1950s and 1960s, it was popular to use the simultaneous-equation approach to allow for endogeneity in a model (Song & Witt, 2006). This approach requires *a priori* restrictions on the parameters of the equations. The VAR model developed by Sims (1980) avoids the problem of imposing incorrect prior information by treating all of the variables as endogenous, except for the deterministic variables such as trend, intercept and dummies (Song & Witt, 2006).

Various VAR models have been widely applied in tourism research. The model specifications usually take a dynamic form (e.g., Oh, 2005; Song & Witt, 2006) and are commonly embedded with an error-correction mechanism (e.g., Bonham, Gangnes, & Zhou, 2009; Schubert, Brida, & Risso, 2011; Seetanah & Khadaroo, 2009; Surugiu & Surugiu, 2013). More recently, both the structural VAR (SVAR) and the structural vector error correction model (SVECM) have received some attention (e.g., Chatziantoniou et al., 2013; Cheng, Kim, & Thompson, 2013; Massidda & Mattana, 2013). These structural models involve imposing *a priori* restrictions on the cointegration vectors in a VECM, so that the long-run relationships between variables are in line with the predictions of economic theories. After the estimation of a structural model, the restrictions are statistically tested to ensure their validity (Garratt et al., 2012; Juselius, 2006). Another strand of VAR models, the Bayesian VAR (BVAR) models, also impose *a priori* restrictions. However, the parameters are restricted to follow prior probability distribution functions rather than fixed numbers. Although the BVAR model has been used to forecast tourism demand (e.g., Gunter & Önder, 2016; Wong, Song, & Chon, 2006), it is still rarely used in tourism research.

VAR models are well suited to research on a number of topics. Many of the studies published since the late 2000s have tested the tourism-led-growth (TLG) hypothesis. Specifically, they use the Granger causality test to determine whether international tourism demand boosts a destination's economy (e.g., Kim, Chen, & Jang, 2006; Kouchi, Nezhad, & Kiani, in press; Nowak, Sahli, & Cortes-Jimenez, 2007; Oh, 2005; Surugiu & Surugiu, 2013; Tang & Tan, 2015). In addition to testing the TLG hypothesis, VAR models have been used to measure the relationship between tourism and other aspects of an economy, such as international trade (e.g., Khan, Toh, & Chua, 2005; Shan & Wilson, 2001), foreign direct investment (e.g., Tang, Selvanathan, & Selvanathan, 2007), and transportation capital (e.g., Seetanah & Khadaroo, 2009).

As discussed above, modelling the interdependence of tourism demand requires treating all of the variables in a model as endogenous. Attempts have been made to approach this topic using VAR models. In one of the earliest studies of the interrelations between tourism markets, Torraleja, Vázquez and Franco (2009) construct a VECM to detect the Granger causality between the incoming tourist flows to one of the five major coastal regions in Spain. Similarly, Seo, Park and Boo (2010) use a standard VAR(p) model to determine the Granger causality between Korea's tourism demand for seven overseas destinations.

One of the problems with both studies is that the causal relationship is not properly accounted for, as their VAR models include only tourism demand variables, leaving out the underlying determinants such as income, prices and exchange rates. Another problem is that only a small number of countries/destinations are studied, and they are chosen on an *ad hoc* basis; thus, the interdependence within a wider range of countries/destinations is omitted. This problem may be associated with one of the limitations of VAR models, which is over-parameterisation or the 'curse of dimensionality', a term coined by Richard Bellman (Bussière, Chudik, & Sestieri, 2009). In a VAR model, the number of parameters to be estimated grows exponentially with every additional endogenous variable, as the additional variable will result in an additional equation to be estimated. In contrast, the number of observations of economic variables during a continuous period is often limited, as are the degrees of freedom. Hence, the estimation of a VAR model can become biased or unrealistic if the number of endogenous variables is fairly large, explaining why studies of interdependence tend to deal with a relatively small number of countries/destinations.

The interdependence of tourism demand has also been handled by models other than VAR models. Chan, Lim and McAleer (2005) apply generalised autoregressive conditional heteroskedasticity (GARCH) models to investigate the interdependence of tourism demand volatility of four leading source markets in Australia. Other GARCH applications include those of Chang, Khamkaew, Tansuchat and McAleer (2011) and Seo, Park and Yu (2009). However, these GARCH model applications do not account for the causal effects of tourism demand determinants. Divisekera (2016) uses an AIDS model to estimate the interdependence of tourism demand for Australia, New Zealand, the UK and the USA, capturing their complementary and substitutive relations. The AIDS models in general face the over-parameterisation problem, as adding additional products (e.g., destinations) to a demand system will lead to additional equations in the system with additional price elasticities to be estimated.

As the interdependence of tourism demand touches all of the major economies in the world, a global model of tourism demand and other macroeconomic variables should include as many countries as possible. A recent development in VAR models, applied mainly in macroeconomic research, is the global VAR (GVAR) modelling approach. It was first proposed by Pesaran et al. (2004), and further developed by Dees, Mauro, Pesaran and Smith (2007) within a global common factor model framework. A few studies have used it to measure the generic links between economic variables such as GDP, inflation, exchange rate, interest rate and equity price (e.g., Chudik & Straub, 2010; Galesi, & Lombardi, 2009; Dees, Mauro, Pesaran, & Smith, 2007; Pesaran et al., 2004). Other studies have a narrower focus, such as the financial market (e.g., Chudik & Fratzscher, 2011; Galesi & Sgherri, 2009), trade flows and capital flows (e.g., Bettendorf, 2017; Boschi, 2012; Bussière et al., 2009; N'Diaye & Ahuja, 2012), the housing market (e.g., Chen, He, & Rudkin, in press; Vansteenkiste & Hiebert, 2011) and the labour market (e.g., Hiebert & Vansteenkiste, 2010). The approach is also a promising tool for forecasting (e.g., Greenwood-Nimmo, Nguyen, & Shin, 2012; Pesaran, Schuermann, & Smith, 2009).

THE GLOBAL VAR APPROACH

The idea of the GVAR approach is to first divide a global model into a number of local models, individually estimate the local models and then stack them to reform the global model. Hence, the need to simultaneously estimate a large set of parameters within the global model is avoided. This section presents the local models for which the parameters are estimated. The remaining steps, such as forming the global model, do not involve statistical estimation. The rationale behind the GVAR approach is described in Bussière et al. (2009), Dees, Mauro, Pesaran and Smith (2007) and Pesaran et al. (2004).

4.1 Model specification

The GVAR approach adopts a two-stage modelling process. In the context of tourism demand modelling, the first stage is to estimate a series of country-specific VECMs augmented with exogenous variables (VECMX). Each VECMX model corresponds to a country. The second stage is to stack the country-specific VECMX models into a global model and rearrange all of the variables and coefficients estimated in the first stage such that each variable has its own equation denoting the causal relationship between it and the remaining variables. The global model has the same form as a standard VAR model.

Following Bussière et al. (2009) and Dees, Mauro, Pesaran and Smith (2007), the first-stage country-specific VECMX model is written in its reduced form as

$$\Delta \boldsymbol{x}_{it} = \boldsymbol{a}_{i0} - \boldsymbol{\alpha}_i \boldsymbol{\beta}_i' [\boldsymbol{z}_{i,t-1} - \boldsymbol{\gamma}_i (t-1)]$$

$$+\boldsymbol{\Lambda}_{i0} \Delta \boldsymbol{x}_{it}^* + \boldsymbol{\Upsilon}_{i0} \Delta \boldsymbol{d}_t + \boldsymbol{\Phi}_i (L, p_i, q_i) \Delta \boldsymbol{z}_{i,t-1} + \boldsymbol{u}_{it} , \qquad (1)$$

where

$\boldsymbol{x}_{it}$ is a $k_i \times 1$ vector of the variables belonging to country $i \in \{1, \dots, N\}$, which are also *domestic variables* in relation to country *i* and are treated as endogenous variables in Equation (1); *N* is the total number of countries;

$\boldsymbol{x}_{it}^*$ is a $k_i^* \times 1$ vector of the *foreign variables* specific to country *i*, which capture the influence of country *i*'s trading partners and are calculated as the cross-sectional averages of the foreign counterparts of country *i*'s domestic variables, i.e., $\boldsymbol{x}_{it}^* = \sum_{j=1}^{N} w_{ij} \boldsymbol{x}_{jt}$, where w_{ij} is the share of country *j* as a trading partner among country *i*'s total trading, and $\boldsymbol{x}_{it}^*$ are treated as *weakly exogenous* variables;

$\boldsymbol{d}_t$ is a $k_d \times 1$ vector of *global common factors*, which are also treated as *weakly exogenous* variables with the exception that in the USA model they are endogenous (see Dees, Mauro, Pesaran, & Smith, 2007; Greenwood-Nimmo et al., 2012);

$\boldsymbol{z}_{it} = (\boldsymbol{x}'_{it}, \boldsymbol{x}^{*\prime}_{it}, \boldsymbol{d}'_t)'$, which collects all of the domestic, foreign, and global variables;

$\boldsymbol{\beta}_i$ is a $(k_i + k_i^* + k_d) \times r_i$ matrix denoting the long-run cointegrating relationships between variables;

$\boldsymbol{\alpha}_i$ is a $k_i \times r_i$ matrix of adjustment coefficients measuring the speed of adjustment to the long-run cointegration;

p_i and q_i are the lag orders of $\boldsymbol{x}_{it}$ and both $\boldsymbol{x}^*_{it}$ and $\boldsymbol{d}_t$, which are decided by the Akaike information criterion (AIC) and Schwarz criterion (SBC);

$\boldsymbol{u}_{it}$ is a $k_i \times 1$ vector of idiosyncratic country-specific shocks, assumed to be serially uncorrelated with a zero mean and a non-singular covariance matrix $\sum_{ii} = (\sigma_{ii,ls})$, where $\sigma_{ii,ls} = cov(u_{ilt}, u_{ist})$ with *l* and *s* denoting the l^{th} and s^{th} variable respectively; and

$\boldsymbol{a}_{i0}$, $\boldsymbol{\alpha}_i$, $\boldsymbol{\beta}_i$, $\boldsymbol{\gamma}_i$, $\boldsymbol{\Lambda}_{i0}$, $\boldsymbol{\Upsilon}_{i0}$ and $\boldsymbol{\Phi}_i$ are the parameters to be estimated.

After the estimation of the above parameters, in the second stage, $\boldsymbol{x}^*_{it}$ in Equation (1) is replaced by $\sum_{j=1}^{N} w_{ij}\boldsymbol{x}_{jt}$ (this also applies to the $\boldsymbol{x}^*_{it}$ within $\boldsymbol{z}_{it}$) and Equation (1) is rearranged so that all of the terms containing $\boldsymbol{x}_{it}$ and $\boldsymbol{d}_t$ appear on the left-hand side of the equation and the rest appear on the right-hand side. Stacking up the rearranged equation (1) across all countries *i* (*i*=1, 2, 3…*N*) yields the global VAR model. As all parameters are estimated during the first stage, no more estimation is needed for the second stage. An illustration of the process can be found in Section 2 of Dees, Mauro, Pesaran and Smith (2007).

In Equation (1), $\boldsymbol{x}_{it} = (rtim_{it}, rtex_{it}, y_{it}, p_{it})$, $\boldsymbol{x}^*_{it} = (rtim^*_{it}, rtex^*_{it}, y^*_{it}, p^*_{it})$ and $\boldsymbol{d}_t = (p_{oil_t})$; $rtim_{it}$ is real tourism imports; $rtex_{it}$ is real tourism exports; y_{it} is the real GDP index; p_{it} is the own price variable (i.e., consumer price index relative to the exchange rate against the US dollar); and p_{oil_t} is the crude oil price. The elements of $\boldsymbol{x}^*_{it}$ are $rtim^*_{it} = \sum_{j=1}^{N} w_{ij} rtim_{jt}$, $rtex^*_{it} = \sum_{j=1}^{N} w_{ij} rtex$, $y^*_{it} = \sum_{j=1}^{N} w_{ij} y_{jt}$ and $p^*_{it} = \sum_{j=1}^{N} w_{ij} p_{jt}$, where w_{ij} is the bilateral trade weight of country *j* among all of country *i*'s trading partners. These variables are chosen in accordance with economic theories and empirical evidence from previous studies of tourism demand and international trade (e.g., Bussière et al., 2009; Li et al., 2005; Smeral & Weber, 2000).

4.2 Impulse response analysis

VAR models are often used to study the dynamic properties of data. Building on a VAR model after estimation, impulse response analysis characterises the evolution of the VAR model in future periods in response to a shock to one of the variables in the model (Pesaran et al., 2004). A shock is an unexpected or unpredictable event that affects an economy either positively or negatively. In impulse response analysis, a shock is often posed as a counterfactual scenario under which the future evolution of the targeted variables is of concern to policymakers. In this study, negative shocks are imposed on China's real income, y_{it}, and its own price variable, p_{it}.

For a GVAR approach, Pesaran et al. (2004) propose using the generalised impulse response (GIR) functions instead of the orthogonalised impulse response (OIR) functions, as the GIR function is invariant to the order of factors in each country and to the order in which the countries are stacked (Dees, Mauro, Pesaran, & Smith, 2007; Pesaran et al., 2004).

Following Pesaran et al. (2004), in this study, the GIR function that denotes the j^{th} shock in $\boldsymbol{u}_t$ (corresponding to the l^{th} variable in the i^{th} country) is given by

$$\boldsymbol{GI}_{x:u_{il}}\left(n, \sqrt{\sigma_{ii,ll}}, \mathcal{I}_{t-1}\right) = E\left(\boldsymbol{x}_{t+n} | u_{ilt} = \sqrt{\sigma_{ii,ll}}, \mathcal{I}_{t-1}\right) - E(\boldsymbol{x}_{t+n} | \mathcal{I}_{t-1}), \qquad (2)$$

where $\boldsymbol{\mathcal{I}}_t = (\boldsymbol{x}_t, \boldsymbol{x}_{t-1}, \ldots)$ is the information set at time $t-1$, n is the number of future periods, $\boldsymbol{x}_t$ is a $k \times 1$ vector that collects the domestic variables across all N countries within the global model and $k = \sum_{i=1}^{N} k_i$; $\sigma_{ii,ll}$ is the variance of the l^{th} variable in country i. On the assumption that $\boldsymbol{u}_t$ has a multivariate normal distribution, it is derived that

$$\boldsymbol{\psi}_j^g(n) = \frac{1}{\sqrt{\sigma_{ii,ll}}} \boldsymbol{F}^n \boldsymbol{G}_0^{-1} \boldsymbol{\Sigma} \boldsymbol{\zeta}_j, \qquad (3)$$

where $\boldsymbol{\zeta}_j$ is a $k \times 1$ selection vector with unity as its j^{th} element (corresponding to a particular shock in a particular country), and zero elsewhere. Equation (3) measures the effect of one standard error shock to the j^{th} equation (corresponding to the l^{th} variable in the i^{th} country) at time t on the expected values of $\boldsymbol{x}_{t+n}$. $\boldsymbol{F}$, $\boldsymbol{G}_0$ and $\boldsymbol{\Sigma}$ have exactly the same definitions as those in Pesaran et al. (2004).

4.3 Data description

For the purposes of GVAR modelling, 24 major countries across the globe are chosen: *South Africa* to represent *Africa*; *Canada*, *Mexico* and the *USA* to represent *North America*; *Argentina* and *Brazil* to represent *South America*; *India*, *Japan*, *Korea*, *Malaysia* and *Thailand* to represent *Asia*; *Austria*, *France*, *Germany*, *Italy*, the *Netherlands*, *Norway*, *Portugal*, *Spain*, *Sweden* and the *UK* to represent *Europe*; *Australia* and *New Zealand* to represent *Oceania*; and China.

There are several considerations behind this choice. The first is that these countries are top tourism destinations and/or top tourist-generating countries, based on the statistics from *Tourism Highlights* (UNWTO, 2013, 2014, 2015); the 24 countries as a whole constantly receive over half of the world's tourists and their spending, and many of the countries are also consistently among the top 10 spenders in international tourism. The second consideration is global coverage; these countries are spread across different continents. The third consideration is data availability.

Quarterly data (1994Q1–2011Q4) on tourism imports, tourism exports, real GDP, consumer price index, exchange rates and oil prices and annual data (1994–2011) on bilateral trade volumes are collected from a number of open sources. Table 1 provides a summary of the data. The quarterly data are used to construct the variables $\boldsymbol{x}_{it}$ and $\boldsymbol{x}^*_{it}$; the annual bilateral trade data are used to calculate the weight variable w_{ij}, a component for constructing $\boldsymbol{x}^*_{it}$; and w_{ij} remains constant across the four quarters within the same year.

[Please insert Table 1 here]

EMPIRICAL RESULTS AND ANALYSIS

The models were estimated using the GVAR toolbox 2.0 (Smith & Galesi, 2014). The data were all log-transformed before estimation. For the country-specific VECMX models in the first stage, the maximum lag order was set to 5. The optimal level was decided by AIC (Nickel & Vansteenkiste, 2013; Pesaran et al., 2009), as it selected lower lag orders than SBC did in the preliminary analysis stage and generated impulse responses that were able to restore long-term equilibrium. Most of the VECMX models used a lag order of 1 or 2 and occasionally 3. Deterministic components in the VECMX models were set as *Case IV: unrestricted intercepts and restricted trend coefficients*, which means that the trend term is restricted to the cointegration space and the level of endogenous variables contains a linear rather than a quadratic trend (more explanations can be found in Garratt et al., 2012 and Juselius, 2006). The rank order of cointegrating relationships, *r*, was determined primarily based on the trace statistics within the Johansen maximum likelihood (JML) approach, which follows Dees, Mauro, Pesaran and Smith (2007). The rank order for most of the VECMX models was usually 1 or 2 and occasionally 0. The following sections present the most important results from the model estimation.

5.1 Contemporaneous impact elasticities

One set of results showing the co-movements across different countries comprises the contemporaneous impact elasticities (Galesi & Lombardi, 2009), defined as the percentage change in a domestic variable in response to a 1% change in its corresponding foreign variable during the current period, i.e., $\mathbf{\Lambda}_{i0}$ in Equation (1). These are also a part of standard reporting in other GVAR studies, such as those by Vansteenkiste and Hiebert (2011), Dees, Mauro, Pesaran and Smith (2007) and Galesi and Lombardi (2009).

The contemporaneous impact elasticities are a good indicator of the synchronisation of business cycles because they demonstrate the extent to which a country's economy co-moves with the economies of its counterparts. Table 2 presents these elasticities. For example, the impact elasticity of Argentina's real income is 0.624, which means that if the real income of other countries increases collectively by 1%, then Argentina's real income will go up by 0.624%.

Furthermore, to check the validity of the assumption that foreign variables $\boldsymbol{x}_{it}^{*}$ are weakly exogenous to the domestic variables $\boldsymbol{x}_{it}$, a test for weak exogeneity is carried out for each country-specific VECMX model (Dees, Mauro, Pesaran, & Smith, 2007). The results confirm that the foreign variables in each VECMX model are all weakly exogenous (test results are available on request).

[Please insert Table 2 here]

As shown in Table 2, each of the 24 countries has at least one statistically significant impact elasticity, confirming the co-movements across countries. European countries tend to have at least two variables with statistically significant elasticities, indicating that they are more integrated into the global economy.

Real Tourism Imports and Real Tourism Exports. About half of the 24 countries have a statistically significant impact elasticity on either real tourism imports or real tourism exports. In many cases, the elasticities sit between 0.5 and 1, meaning that the strength of the synchronisation within the worldwide tourism sector is generally moderate. Specifically, the outbound tourism demand (denoted by real tourism imports) of developed countries such as Australia, Canada, Norway and the USA co-move tightly with the worldwide outbound tourism trend, probably because citizens of developed countries are more active in traveling abroad and are usually among the top spenders. As to the inbound tourism demand (denoted by real tourism exports), countries such as France, Italy, the Netherlands, Portugal and Spain are well synchronised with the developments of worldwide inbound tourism, and are usually among the top destinations, capturing large numbers of tourists.

Real Income and Own Price. The impact elasticities on real income and own price are generally significant for the 24 countries, which suggests that the macroeconomic performance of these countries is synchronised. The impact elasticities on real income are usually between 0.7 and 1, which is more sensitive than those on tourism variables. In terms of their size, the elasticities on real income are generally consistent with those reported in other studies, such as those of Dees, Holly, Pesaran and Smith (2007), Dees, Mauro, Pesaran and Smith (2007) and Galesi and Lombardi (2009). The impact elasticities on own price are even more sensitive, mostly sitting between 1 and 1.5. There are exceptions in some Asian countries and emerging economies, where the elasticities on own price are not statistically significant.

Overall, the co-movements within tourism variables are less sensitive and less widely observed than those within real income and own price, perhaps due to some intrinsic differences between international tourism demand and macroeconomic factors. International tourism demand, although determined by macroeconomic factors, may be simultaneously influenced by non-economic factors (e.g., preferences, visa policies). As a result, there may be some persistence within the tourism demand for a particular country, making its elasticities less sensitive.

The results in Table 2 imply that the real income and own price levels of most of the major countries are widely linked to the performance of the world economy, whereas the countries' tourism demand (inbound and outbound) may influence each other less. For those countries with statistically significant elasticities on either real tourism imports or real tourism exports, a managerial implication of this for a tourism destination would be to take measures to manage the sector's fluctuations in the face of external changes, such as diversifying their tourism products and choice of leisure activities.

5.2 Impulse responses to a negative shock to China's real income

The impulse responses of two negative shocks to the Chinese economy are simulated in the following sections. As a result of cross-country interdependence and the spillover effects of the Chinese economy, other countries' variables may experience synchronised fluctuations after a shock. This pattern reflects the locomotive hypothesis described in Section 2.2, where idiosyncratic country-specific shocks are assumed to be transmitted across borders.

It should be noted that the impulse responses are influenced by the size of the shock, the horizon after the shock, and the estimated parameters in the model (see Equation 3); however, they are not related to a specific point in time. Hence, the shocks and impulse responses simulated in the following sections represent counterfactual situations that are likely to occur, but not necessarily immediately.

Following other studies using the GVAR model (e.g., Galesi & Lombardi, 2009; Galesi & Sgherri, 2009), the impulse responses of individual countries are aggregated regionally to provide an overview of the global effects of the shocks. Pesaran et al. (2004) argue that within a GVAR model it is easier to analyse a few key countries individually and to aggregate the remaining countries into several blocks/regions.

Figures 1 and 2 show the impulse responses of a negative shock of one standard error to China's real income (bootstrap median and 90% confidence bands). This is equivalent to an instant 2.7% fall in China's real income. Although it may have a relatively limited effect on the real income of other regions, the shock would cause a noticeable decrease in the own price variable of almost every region in the long run (after 20 quarters), particularly Asia, China, Europe and South America. This decrease in the own price level across regions can be conducive to both inbound and outbound tourism in any region.

Regarding tourism demand, China's real tourism imports and real tourism exports would suffer from a temporary decline in the first eight quarters, but rebound in the long run. It would be important for tourism-related businesses in China to take short-run measures, such as cutting labour costs and increasing marketing activities, to counter the short-run decline in both inbound and outbound tourism demand. In comparison, the real tourism imports and exports of other regions would tend to be affected during the first four to eight quarters. Over the long run, a notable example is South America, whose real tourism imports would decrease by about 2% and real tourism exports would go up by 1.7%, suggesting that local businesses in South America should be prepared for an increased inbound tourism demand after a shock to China.

Overall, the impulse responses of different regions are found to be synchronised for the own price variable constantly and for real tourism imports in the short run. Tourism-related businesses in almost every region should take advantage of the downward changes in their own prices to attract incoming tourists. South America in particular is likely to experience a long-run downward effect on its own price variable and real tourism imports and a long-run increase in its real tourism exports. This shows that China's real income level is a highly relevant variable for South America's tourism-related businesses to monitor.

5.3 Impulse responses to a negative shock to China's own price variable

The second shock investigated is a one standard error negative shock to China's own price variable. This is in accordance with some speculation that the Chinese currency could experience a depreciation and become more volatile. The impulse responses (bootstrap median and 90% confidence bands) are shown in Figures 3 and 4.

The shock would immediately result in a 2.0% decline in China's own price variable in the same quarter as the shock, equivalent to a deflation in US dollar terms. This deflation would be rather persistent over the long run, slightly above 1.0% even after 40 quarters. For most of the other regions, the fluctuations in the own price variables would be particularly evident and synchronised during the first eight quarters, but would tend to disappear after twelve quarters. The real income variables across regions would be only slightly changed, irrespective of the horizon. With regard to tourism demand, China would see a long-lasting contraction in both real tourism imports (-1%) and real tourism exports (-0.2%). Consequently, travel agents arranging overseas trips for Chinese tourists would have to make an effort to counter the long-run decrease in Chinese outbound tourism demand. The other regions are likely to experience short-run fluctuations in their international tourism demand, especially during the first four quarters after the shock. Flexible employment arrangements such as part-time contracts and seasonal contracts would be helpful for tourism-related businesses to manage operating costs. However, long-run negative effects would still exist for the real tourism imports of Asia (-0.97%) and South America (-1.6%), and for the real tourism exports of Asia (-0.5%), Oceania (-0.9%) and the USA (-0.7%).

A managerial implication of a negative shock to China's own price variable is that tourism-related businesses in some regions could be worse off due to a long-run decrease in inbound tourism demand. At the local level, tourism-related businesses in those regions should thus be prepared for a long period of underperformance, and could consider diversifying their businesses to cater to domestic tourists.

[Please insert Figure 1 here]

[Please insert Figure 2 here]

[Please insert Figure 3 here]

[Please insert Figure 4 here]

CONCLUSION

This study examines the interdependence of 24 major countries. It adopts the GVAR approach to calculate the contemporaneous impact elasticities and the impulse responses of exogenous shocks.

The estimation results are particularly relevant to tourism policymakers and multinational corporations that monitor their macroeconomic environment, especially in times of turbulence. At the macro level, contemporaneous impact elasticity is a measure of the level of a country's global integration, as it shows the size of co-movements between a focal country and other major countries. At the corporate level, the elasticity can be used as a general indicator of the variations in local economies. Knowing the size of the changes their local economies will experience in response to changes in the global economy allows businesses to further evaluate the effects on their profitability and make informed decisions about procurement and employment. Impulse response analysis is useful for mapping the developments of worldwide tourism demand under the influence of a country-specific event. A shock to China's real income or own price variable would cause short-run synchronised fluctuations across both the developing and developed regions, whereas long-run effects would tend to be evident in the developing regions and in China's neighbouring regions. Tourism-related businesses should allow for sufficient production flexibility (e.g., flexibility in employment arrangements) during the timeframe when their tourism demand and local economies are experiencing volatility. The impulse responses simulated in this study suggest that the first eight quarters after a shock to China's real income and own price would generally be volatile for many regions. In the long run, the impulse response analysis shows that some regions may face long-lasting effects on tourism demand.

The current study fills a gap by modelling tourism demand in a setting where there is cross-country interdependence. It contributes to the theoretical and practical knowledge of tourism demand, especially the endogeneity within worldwide tourism demand.

Some limitations of the current study are worth mentioning. One limitation is that the model includes only country-specific variables that are endogenous across countries (i.e., cross-sectional), and omits those that may affect an individual country but are not interrelated across countries, such as visa policies. Another limitation concerns geographical coverage. The current study includes 24 major countries to represent the global system. However, some channels of spillover may be left unaccounted for, as not all countries are included in the model.

A third limitation is that the impulse responses may be deemed nonsignificant, as confidence bands contain zero in most cases. This pattern is also observed in other GVAR studies (e.g., Dees, Holly, Pesaran, & Smith, 2007; Galesi & Lombardi, 2009; Koukouritakis, Papadopoulos, & Yannopoulos, 2015). This may be due to the aggregation of impulse responses at a regional level, higher volatility in estimates associated with relatively high frequency data and/or model parameters derived from unrestricted estimations (Galesi & Lombardi, 2009).

In terms of research topics, as discussed in Section 2, the current study examines only the interdependence of tourism demand, and should be complemented by a further investigation from the perspective of tourism supply, i.e., the business side. The GVAR approach has plenty of further potential for tourism research. Future studies could continue to explore the interdependent nature of the global tourism sector by applying time-varying parameter techniques to capture the changes in contemporaneous impact elasticities over time. The GVAR approach could be combined with Bayesian statistics to deal with the over-parameterisation issue. Regarding the scope of study, the GVAR approach could also be applied to a regional context with active intra-regional tourism, or used to explore the interdependence of tourism and other sectors within an economy. In addition, the approach could be used to forecast tourism demand across a range of countries to generate robust forecasts, as it accounts for interdependence across countries.

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FIGURES

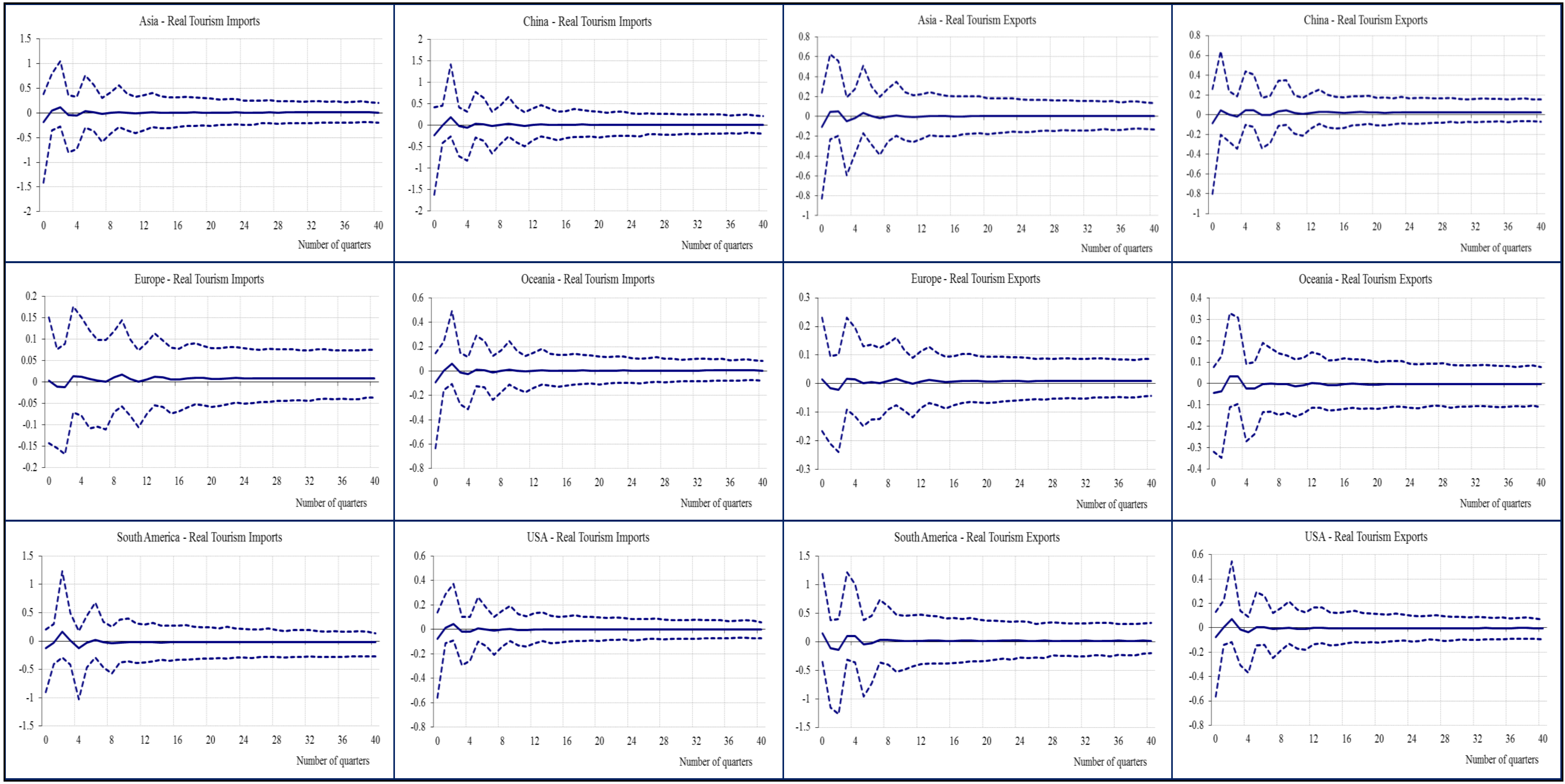

Figure 1 - Generalised impulse responses of a negative shock to China's real income on real tourism imports and real tourism exports

Note: The above regions are among China's top source markets and/or top destinations.

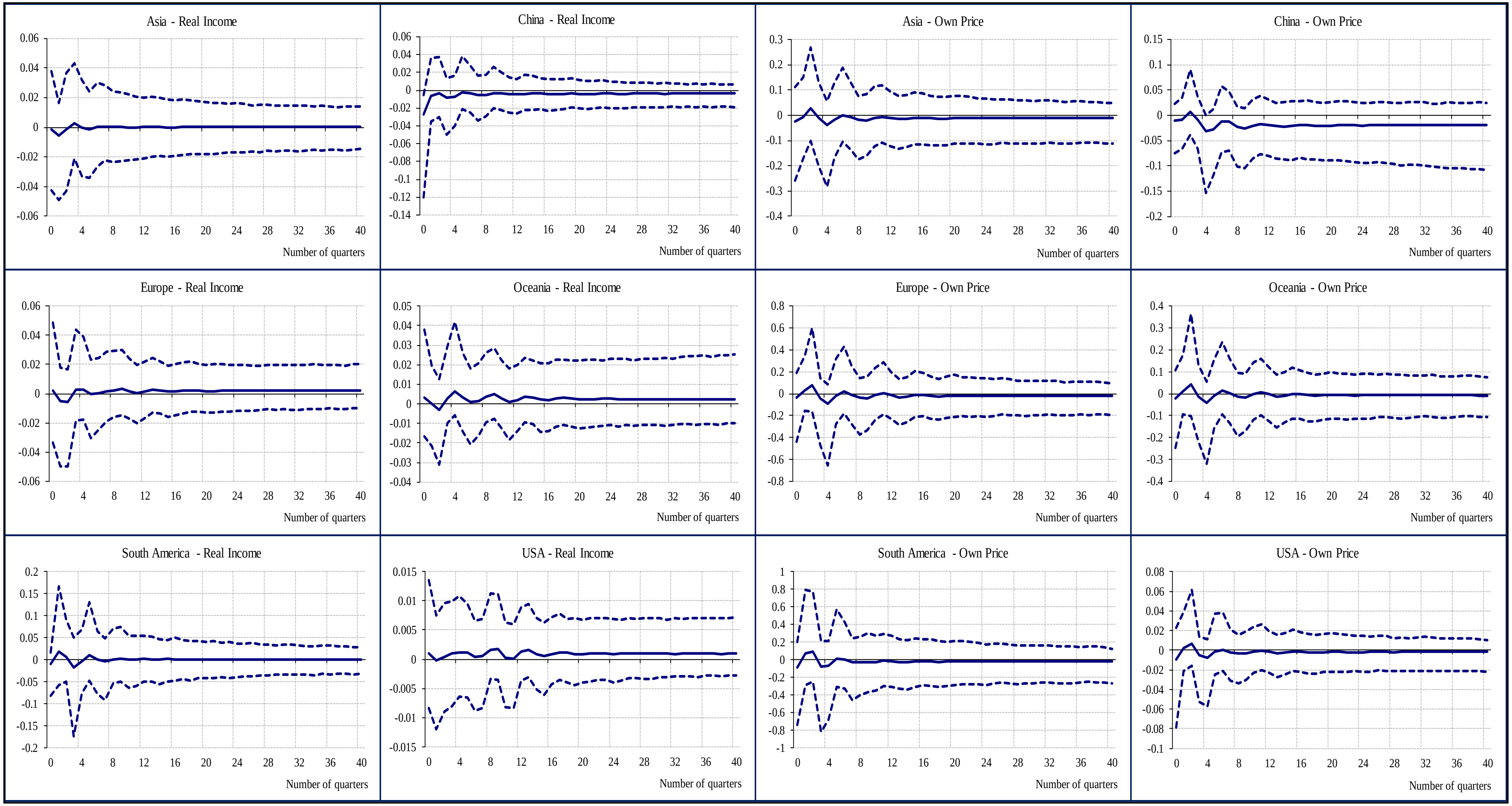

Figure 2 - Generalised impulse responses of a negative shock to China's real income on real income and own price variable

Note: The above regions are among China's top source markets and/or top destinations.

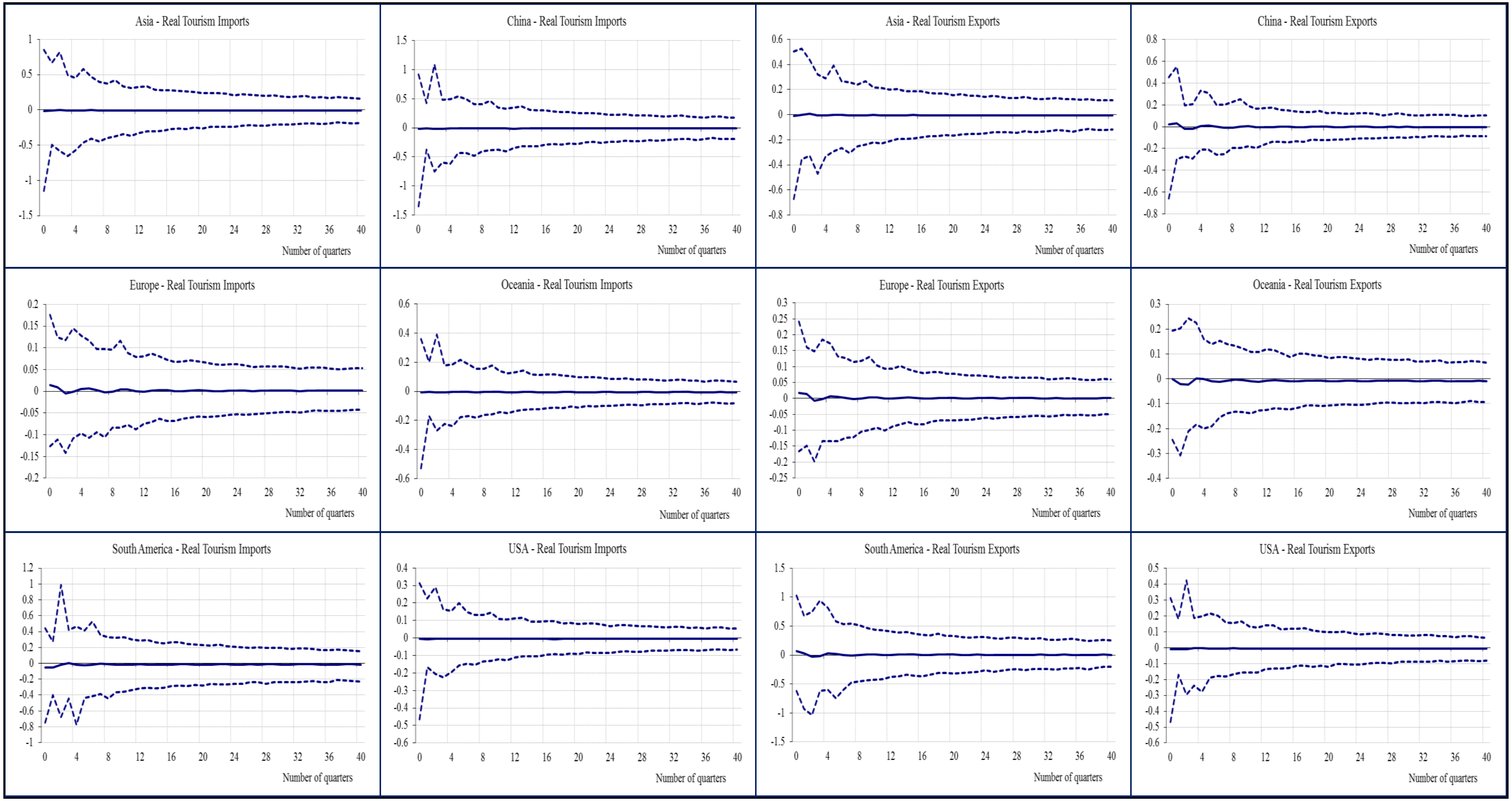

Figure 3 - Generalised impulse responses of a negative shock to China’s own price variable on real tourism imports and real tourism exports

Note: The above regions are among China’s top source markets and/or top destinations.

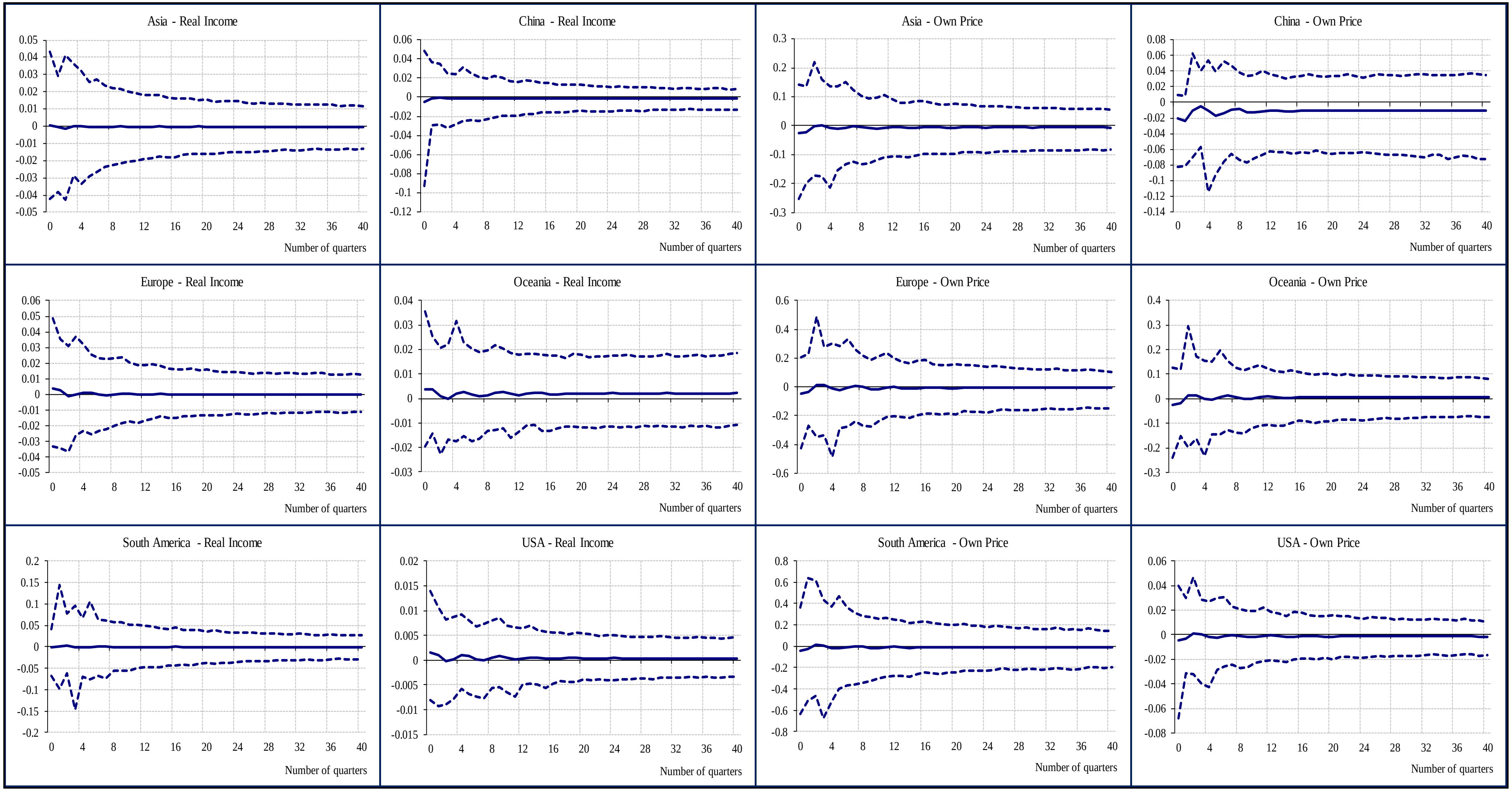

Figure 4 - Generalised impulse responses of a negative shock to China's own price variable on real income and own price variable

Note: The above regions are among China's top source markets and/or top destinations.

TABLES

Table 1 - Summary of data sources

Variable	Measure	Frequency	Source
Tourism imports	Travel debits (million US$); passenger transport debits (million US$)	Quarterly	Balance of Payments Statistics Yearbook (BPM5), IMF
Tourism exports	Travel credits (million US$); passenger transport credits (million US$)	Quarterly	Balance of Payments Statistics Yearbook (BPM5), IMF
Real GDP index	Real GDP index (base year 2005 = 100)	Quarterly	International Financial Statistics, IMF; national statistical offices
Consumer price index	CPI (base year 2005 = 100)	Quarterly	International Financial Statistics, IMF; main economic indicators, OECD
Exchange rates	National currency against US dollar	Quarterly	International Financial Statistics, IMF
Oil prices	Petroleum: average crude price (US$ per barrel)	Quarterly	International Financial Statistics, IMF
Bilateral trade volume	Average of exports and imports (in US$)	Annual	Direction of Trade Statistics, IMF

Note: All the data cover the period from 1994 to 2011.

Table 2 - Contemporaneous impact elasticities between foreign variables and domestic variables

	Real Tourism Imports *($rtim^*$, rtim)*	Real Tourism Exports *($rtex^*$, rtex)*	Real Income *(y^*, y)*	Own Price *(p^*, p)*
Argentina	-	0.136	0.624*	-0.149
Australia	0.590***	0.006	-	-
Austria	-0.641	-0.017	0.639***	1.163***
Brazil	0.776*	0.882	0.847***	1.088*
Canada	0.348***	-	-	-
China	0.010	0.368	0.599**	0.109*
France	0.406	0.752**	0.809***	1.300***
Germany	-0.071	0.187	0.920***	1.436***
India	1.958*	0.153	0.739***	0.774***
Italy	0.373	0.841***	0.852***	1.336***
Japan	-	-	0.776***	0.614
Korea	-0.009	-0.479	0.886***	0.438
Malaysia	-	-	1.082***	0.848***
Mexico	0.824**	0.261	2.360***	0.203
Netherlands	0.553	0.506*	0.827***	1.349***
New Zealand	0.394	-0.324	0.796***	1.715***
Norway	0.732***	0.008	0.903**	1.077***
Portugal	0.352	0.548**	0.964***	-
South Africa	0.154	0.864	0.408***	1.262***
Spain	0.351	0.373*	0.982***	1.298***
Sweden	0.857	0.121	1.358***	1.280***
Thailand	1.212***	-0.070	0.551	1.461***
UK	0.146	0.042	0.637***	0.553***
USA	0.551***	0.077	-	0.140***

Notes:

*a) ***, **, *: statistically significant at the 1%, 5%, and 10% level, respectively.*

b) The numbers denote the percentage change in a domestic variable in response to a 1% change in its corresponding foreign variable during the sample period 1994Q1–2011Q4.

c) Domestic variables are rtim, rtex, y and p; foreign variables are $rtim^*$, $rtex^*$, y^* and p^*.

d) -: The foreign variable is not used in the VECMX model.