A Structural Approach to the Globalization Hypothesis for National Inflation Rates*

Francesco Bianchi† and Andrea Civelli‡

27 March 2010

Abstract

This paper studies the relation between globalization and national inflation rates, contributing to the recent debate about the effects of the increasing integration of the world economy on national inflation processes which sees the thesis of Borio and Filardo (07) opposed to that of Ihrig et al. (07). We construct a new dataset, comparable to the one used in Ihrig et al., for a large sample of eighteen countries and we estimate a time varying coefficients VAR for each of them. From the reduced form estimates of the VAR, we find evidence supporting the view against the Globalization Hypothesis. However, the results from the structural version of the VAR depict a more interesting and elaborate picture. Globalization has had a significant role in determining the dynamics of inflation for many countries since the 70's. These deeper relations could not emerge from the simple univariate Phillips Curve regressions. Nevertheless, the actual modest increase in openness of the last three decades did not determine any particular time evolution of the structural relations. Finally, a comparison across countries relates the importance of the role of globalization positively to the degree of openness of a country and to the degree of idiosyncrasy of its business cycle.

JEL Classification: E31, F02, F41

Keywords: Globalization, Inflation, time-variation

*We are grateful to Alan Blinder, Nicola Zaniboni, John Seater and seminar participants at Princeton University and NC State University for useful suggestions and comments. We thank Jane Ihrig for sharing with us her data set at an early stage of this work.

†Duke University. Correspondence: Duke University, 213 Social Sciences Building, Box 90097, Durham, NC 27708-0097. Email: francesco.bianchi@duke.edu

‡University of Arkansas. Correspondence: Department of Economics, Business Building 402, Fayetteville, AR 72701. Email: andrea.civelli@gmail.com

1 Introduction

What are the implications of globalization for national macroeconomic outcomes? Has the increasing internationalization of goods and financial markets changed the way global factors affect national inflation rates and business cycles? The Globalization Hypothesis (GH) provides a very appealing and intuitive answer to this type of question: as the integration of the world economy increases, the dependence of national outcomes on international factors has to increase as well. Global determinants will eventually replace the more traditional domestic factors.

The versatility of the GH idea, however, calls for some caution in its application. Let us take the dynamics of national inflations across the world as an example. The GH has been successfully invoked in the recent past to interpret some well documented empirical facts in the global dynamics of inflation, in particular, the common reduction in volatility and levels of national inflations as reported by Figure 1[1]. Ciccarelli and Mojon (05) and Mumtaz and Surico (08) show that a common global factor has driven this reduction and they relate this factor to the degree of openness of the world economy.

It is, in fact, a common belief that openness of individual countries has widely increased in the last few decades and that this might have largely affected their inflation processes. In Figure 2, we take the ratio of the sum of imports and exports to GDP as a measure of openness and plot it for ten countries including US, Japan, Germany, UK, and China (and others) since the 70's. In these economies, the ratio has increased on average by 5 to 10 percentage points. Tighter comovements of national inflation rates across countries and this evidence of the higher, even though not particularly rapid, integration occuring in the goods markets led some authors to extend, in a presumably natural way, the GH to two other aspects of the national inflation dynamics.

The first is the Phillips Curve relation, which in a closed economy has traditionally been used to link short run movements of inflation to the domestic output gap. The main implication of the GH in this respect is that global slackness should have progressively replaced domestic output gap in driving national inflation rates. This is one of the main focuses of this paper too. The second is the so-called China effect, the view that lower import prices from emerging economies may have reduced prices in the industrialized countries. Surprisingly, however, although one would consider these two applications of the GH intuitively sound, neither of them finds an unambiguous confirmation on the empirical ground.

In a famous paper that has spurred much debate, Borio and Filardo (07) study an open economy version of the domestic Phillips curve for a large set of countries. They include in the Phillips curve a measure of

[1] Figure 1 replicates a graph in Mumtaz and Surico (08) and plots the time series of national inflations for the countries included in our sample for the construction of the trade-based weights. The three thicker lines represent the average and top/bottom fifth percentiles of the distribution of the inflations.

the specific foreign gap for each country in their sample and provide evidence in favor of the GH. On the other hand, Ihrig, Kamin, Lindner, and Marquez (07)[2] show that Borio and Filardo's conclusions crucially depend on the particular reduced form of the regression they adopt in testing the hypothesis and on how they treat inflation expectations[3].

Even from the theoretical perspective, there is no full agreement on the impact of greater globalization and of the foreign business cycle on domestic inflation. Rogoff (03) suggests that higher international competition should make the Phillips curve steeper, but the empirical evidence definitely points in the opposite direction. Ball (06) notices that, even though firms compete in more integrated markets, the output gap enters the Phillips curve because it approximates firms' marginal costs. While competition reduces the average markup making the Phillips curve potentially flatter, the foreign output gap would replace the domestic gap only if marginal costs had started to depend more on the foreign gap instead of the domestic one, but he does not see any particular reason to believe this.

In this paper, we present a more structural study of this particular implication of the GH that occupies the center of the debate between Borio and Filardo (07) and Ihrig et al. (07). The analysis tackles two main questions.

First of all, it is important to understand whether Globalization matters for the dynamics of domestic inflation at all. This point is important empirically, from a monetary policy perspective, and theoretically, since the New Keneysian open economy literature explicitly recognizes a primary role to foreign forces in the determination of the domestic macroeconomic dynamics. We show this role is deeper, in the sense of being more structural, than what the Phillips Curve per se has revealed so far. Following a structural approach to the problem allows us to uncover significant indirect effects, even when, as in this case, there are no other evident direct effects.

Once the importance of these global effects for inflation is assessed, the second interesting point is to verify whether the impact of the foreign output gap on domestic inflation rates has changed over time in a way consistent with the GH, as tested by Borio and Filardo (07). We find that these effects can be related to the process of internationalization that has characterized the global economy since the 70's, but they have basically remained unchanged for the last three decades.

We pursue these two goals providing two key contributions. First, we construct a new dataset, comparable to the one used by Ihrig et al., which allows us to have a homogenous definition of the foreign gaps and the real exchange rates across countries for a very large set of nations. Those measures are constructed using a set of trade-based weights computed adopting the methodology presented by Loretan (06), and in particular

[2] Borio and Filardo come from the Bank of International Settlements (BIS). Ihrig, Kamin, Lindner and Marquez from the American Federal Reserve Board.

[3] Borio and Filardo show that their results hold for different measures of the country specific relevant foreign output gap too.

our weights take into account the changes in the trade relations among about 50 countries over the sample 1970 to 2006. A particularly sensitive point of our analysis turns out to be the relatively moderate increase of the openness in many countries. This large pool of countries allows us to cope with it by comparing a cross-section of countries with different degrees of openness and not only looking at the change over time of openness for individual countries.

Second, we base our results on the estimates of country-by-country time varying coefficients VARs with stochastic volatilities. For each country, we can supplement the estimates of the coefficients of the Phillips Curve with the information from the impulse response functions of inflation to shocks to the domestic and foreign output gap, which receive a structural interpretation through the identification scheme of the VAR. The time varying nature of our estimates allows us to compute the impulse response functions at different points in time and to check whether their shape and significance have changed over the sample.

Compared to the previous literature, our approach presents two advantages. First of all, it avoids those specification issues related to the treatment of the inflation expectations which have negatively affected Borio and Filardo's results. The model itself generates these expectations using the information currently available at each point in time in the VAR. Second, the crucial point in the analysis of this problem is to investigate the change over time of the relations between inflation and other relevant variables in the economy. In this respect, the time varying coefficients VAR is a very suitable and flexible tool and it is a clear improvement over subsample analysis and rolling estimations. Furthermore, letting the model distinguish between changes in the coefficients and changes in the magnitude of the shocks allows accounting not only for the variation in the structure of the model, but also for the reduction of volatility of shocks which occured in the last two decades as documented by the "good luck - good policy" literature which may hide important effects.

We first estimate the reduced form VAR's and obtain a set of results comparable to those presented by Borio and Filardo (07) and by Ihrig et al. (07). Then we move to the structural version of the model and use this new type of evidence to achieve a deeper understanding of the role of the foreign gap in the determination of the dynamics of domestic inflation rates.

The first set of results is based on the estimates of the inflation equation in the reduced form VAR. We interpret this as our empirical counterpart of the Phillips Curve and we basically agree with Ihrig et al. in concluding that the GH fails to hold in this framework. However, the results from the structural estimates and the impulse response functions of inflation to shocks to the domestic and foreign output gap introduce several new elements in the analysis which depict a quite different and more complicated picture.

We observe that the response functions to the domestic gap shocks are positive and significant for half of the countries in our sample, but a flattening of the profiles of these functions does not emerge. The responses to the foreign gap shocks are consistently positive and significant too for many of the countries and over time, yet they do not show any particular time pattern.

The relations among variables at the level of the Phillips Curve may indicate that the foreign gap does not matter for the dynamics of inflation, the structural evidence emphasizes a completely new and more intrinsic role for it which was missed in the previous interpretation of the GH. The focus is shifted, in particular, to the lack of time evolution in the response functions which suggests to us that the increase in the degree of openness that has occured in the past three decades has been too small to induce any change in the structural relations among variables of the model.

Under this level of integration, globalization has systematically affected the dynamics of domestic inflation, but the small increase in integration did not determine the correct premises to make these effects become stronger over time. The question of whether those effects will be detectable in the Phillips Curve in the future, once globalization increases even more, remains without a certain answer.

A unified interpretation of our findings is difficult, however two interesting features emerge from the comparison of the results across countries. First, the effects of the foreign output gap shocks on inflation are positively related to the degree of openness of a country. This is particular evident if we compare the US, for example, to the European countries or to Canada. Second, besides the degree of openness, the coordination of the domestic business cycles with the international cycles seems to matter. The degree of idiosyncrasy of a country is positively related to the significance of the responses of inflation to the foreign output gap shocks.

These two factors can combine in different ways and often compensate each other. This happens, for example, with many European countries which are well integrated in the economic enviroment of the EU and, at the same time, very open economies. Another example is Japan, where a high degree of idiosyncracy offsets the limited openness of the country.

The rest of the paper is organized as follows. In Section 2 we introduce the implications of the GH first tested by Borio and Filardo (07), we summarize the terms of the debate between them and Irigh and al. (07) and relate it to the theoretical New Keynesian framework currently used to set up open economy general equilibrium models. In section 3 we present the motivations and goals of our approach. Section 4 briefly outlines the estimation methodology and the dataset we use, more details are necessarily left to Appendix A and B. Section 5 presents and interprets the results for the eighteen countries in our sample; and the final Section concludes.

2 The Globalization Hypothesis

2.1 Controversial Empirical Evidence

The Phillips Curve relation shows the short-run trade off between a country's inflation and its domestic output gap. Although it has a sound theoretical micro foundation in the new Keynesian model, it has not always been characterised by strong empirical regularity. However, the declining slope of the relation which is typically found using the most recent data, along with the narrowing comovements of inflations across countries and the increasing integration of the global economy over the last two or three decades, have suggested a new role for the international forces in driving national inflation outcomes.

In particular, the Globalization Hypothesis implies three main predictions with regard to the Phillips Curve, which can be formulated referring to the open economy version of the standard expectation augmented Phillips Curve presented in (1), where the foreign output gap y_t^f and the import price inflation π_t^m have been added to the domestic gap y_t^d and the expected inflation $E_t\pi_{t+1}$ in the regression equation for domestic cpi inflation π_t[4].

$$\pi_t = E_t\pi_{t+1} + \beta y_t^d + \delta y_t^f + \gamma\pi_t^m \tag{1}$$

1. The first prediction is that the role played by y_t^d should become increasingly less important as openness increases. This implies declining estimates of β both in closed and open versions of the Phillips Curve.

2. The second is that y_t^f should progressively replace y_t^d as global integration increases, which means δ must be significantly positive and possibly increasing over time.

3. Finally, the third prediction is that also γ should increase, since the responsiveness of π_t to import prices should be greater for higher degrees of openness.

These predictions of the GH sound very intuitive and appealing; someone would consider them almost obvious in some sense if related to the mounting evidence of the existence of global factors driving national inflation rates presented by Ciccarelli and Mojon (05) or Mumtaz and Surico (07), for example. However, there is no clear empirical evidence supporting the GH per se, which is not necessarily in contradiction with the presence of global dynamics since those factors can be attributed to a stronger international coordination of monetary policy practices or to tighter international linkages without necessarily going through the impact of foreign slack on domestic inflations. In particular, the results of Borio and Filardo (07) (BF henceforth)

[4]The specification of the term π_t^m varies among authors. In some cases, it is the inflation of import prices or the unit labor cost, as in Borio and Filardo (07), while in other cases it is taken in deviation from the home country inflation as in Ihrig et al. (07).

in favor of the GH implications are disputed with resolution by Ihrig et al. (07) (IEA henceforth).[5]

Being that all these empirical results are based on estimates of (1), it is easy to imagine how the differences between these two opposed views are crucially determined by the specific empirical regression equation used to test the hypothesis. Furthermore, the results would depend on the definition of the relevant foreign output gap for each country.

The key aspect of (1) is the expectational term $E_t\pi_{t+1}$. BF use an HP filter of the core inflation series as a proxy for the underlying trend cpi inflation and consider this a better formulation of expectations than using purely autoregressive terms. They find positive and increasing δ along with decreasing β for the majority of the countries in their sample.

This approximation of expectations has a backward looking nature; it allows for the separation of the cyclical component of the inflation from the trend and, more importantly, leaves enough variability in the dependent variable for the regression to detect the relative contribution of domestic and foreign gaps to the persistence of inflation. The residuals of the regression will be autocorrelated, but correcting for this autocorrelation would basically kill the estimates of β and δ.

Even though autocorrelated residuals do not bias the estimates of the coefficients of a regression, this is commonly taken as an indication of mispecification of the equation. IEA show that once the HP filter is replaced by a few lagged values of π, recovering a more econometrically correct specification, the significance of δ is expunged almost everywhere. This is definitely a strong piece of evidence against the GH, but additionally, under the same specification, the significance of β is seriously compromised for more than half of the countries they study, which is not a desirable feature.

IEA show also that BF's results are very sensitive to changes in the definition of the foreign gap, even when their treatment of expectations is adopted, which introduces a delicate issue about the construction of homogenous measures of foreign output gap across countries.

There is large agreement that the slope of the Phillips Curve has become flatter over time and this has been commonly associated with the higher degrees of economic openness that have characterized the last two decades; this is BF's view as well. Also IEA find that β has been declining in the most recent portion of their sample, but they show that this association is not actually supported by the data.

Finally, IEA find only weak effects of import prices on domestic inflation. The estimated γ is generally only slightly significant and often of the wrong sign; it does not significantly increase over time and can be only marginally related to increases in trade openness. In this respect, BF's results are similar to those in IEA since their estimates of γ are usually significant, but extremely small if compared to δ. In their

[5] Borio and Filardo (07) and Ihrig et al. (07) are definitely the most representative papers of the two opposing views. Ihrig et al. (07) provides an exhaustive review of the empirical literature in favor and against the GH.

specification, import prices can help to improve the fitting of the Phillips Curve, but do not modify the importance of the foreign gap at all. BF find similar results also for other international prices which might be relevant in explaining domestic inflation such as the price of oil, a global wholesale price variable and a measure of the global unit labor cost.

2.2 Theoretical Considerations

The New Keynesian Phillips Curve is a well known result of the modern general equilibrium models. It is a forward looking equation that relates the CPI inflation to the marginal costs of optimizing firms, which set prices according to a Calvo (83) price setting scheme. The labor supply optimal condition of the consumer and the production function then allow to express the marginal cost in function of the output gap and to derive the standard representation of the Phillips Curve.

The same modeling device has been applied to open economy models too. If firms can export their goods to a foreign country and are allowed to price discriminate between home and foreign markets, the cross border pricing decision introduces a dependence of the inflation of a country on the marginal cost of the exporting firms in the other country and, therefore, on the foreign country output gap. Clarida, Gali and Gertler (02) and Corsetti and Pesenti (05) introduced it for the analysis of international montary policy; Gali and Monacelli (05) and Monacelli (05) refined it for the small open economy case; after that it soon became the horsework model in the open economy DSGE literature.

This can be regarded as a natural extension of the closed economy framework to the open economy, but, even more significantly, it must be recognized that it provides the theoretical background at the base of the Globalization Hypothesis and of the implications we are empirically discussing in this paper. The specification of the Open Economy New Keynesian Phillips Curve corresponding to the empirical specification adopted in (1) varies according to the details of each model; however, with local currency pricing, home bias in consumption and perfect risk sharing, it usually reads

$$\pi_t = \mu E_t \pi_{t+1} + \nu \left((1-h)\, y_t^d + h y_t^f \right) + \Gamma_t \tag{2}$$

We just want to point out a few characteristics of (2), without illustrating the detailed derivation of this equation, since it would be far beyond the scope of this paper. A rigorous micro foundation of it can be found in the papers cited above, in Steinsson (08) for heterogenous labor markets and Zaniboni (08) for the difference between local currency and producer currency pricing.

First of all, a brief description of the coefficients in (2) is necessary. The CPI inflation π_t presents a forward looking term multiplied by μ, the intertemporal discount factor in the utility function of the consumer. Then it depends on the weighted average of the domestic and foreign output gap; the weight $(1-h)$ is the consumption home bias coefficient, ν summarizes the responsiveness of inflation to the marginal cost and of the marginal cost to the output gap, and it is a combination of the deep structural coefficients of the model[6]. The last term Γ_t accounts for the impact on inflation of some measure of international competitiveness. This measure is model specific, but it can usually include the term of trade, the deviation from the law of one price of import prices, the deviations from purchasing power parity of the real exchange rate.

Second, (2) makes it evident that the foreign output gap should enter the Phillips Curve equation in a direct way and its coefficient should be smaller relative to the domestic gap coefficient if there is home bias in consumption. This is the aspect on which empirical studies have focused so far. However, the output gap can potentially matter also in an indirect way through the structural relations which are missing from plain considerations based on the reduced form.

In particular, the foreign output gap may affect the level of natural domestic output and can have an impact on the behavior of the Γ_t term. Furthermore, the degree of openness interacts with it in the determination of the natural output and should reduce the elasticity of the marginal cost to the two output gaps.

The structural identification of the shocks in our time varying VAR is meant to account for these structural effects, even when the reduced form estimations point against a significant role of the output gap. Zaniboni (08) for example shows, from a theoretical point of view, that for sensible calibrations the coefficient of the foreign output gap in the Phillips Curve is small and definitely dominated by the coefficient attached to the domestic gap; furthermore, the coefficient only slightly increases in function of the degree of openness in a realistic range of openness. It is reasonable to imagine that a regression could neglect this coefficient, in particular if the inflation expectations term is misspecified.

What about the impulse responses of inflation to foreign and domestic outputgap shocks then? Figure 4 reports these impulse response functions for the local currency pricing model and the main calibration in Zaniboni (08) and for a home bias parameter of 0.8, which implies a Phillips Curve coefficient of 0.42 and 0.1 for the domestic and foreign output gap respectively[7]. The response of inflation in impact to a 1% shock to the domestic gap is about 0.7% and to the foreign gap is about 0.15%, the foreign response is always smaller than the domestic response and is increasing in the degree of openness. These simple theoretical results suggest a potentially interesting, albeit clearly less significant, role for global slackness. The propagation of

[6]These structural coefficients are: the probability firms have of adjusting the price at each period in the Calvo model, the elasticity of substitution between home and foreign goods, the intertemporal elasticity of substitution and the labor supply elasticity in the utility function of the consumer, h and μ.

[7]We add an autoregressive shock to the two output gaps, assuming the standard deviation of these innovations to be half of the standard deviation of the technological shocks and an autoregressive coefficient of 0.8.

the foreign gap shock can occur through other channels, as, for example, through the movements of the term of trade, the effects on the aggregate demand of the domestic country or different monetary policy settings.

3 Our Approach

We propose to study the GH by using time varying coefficients national VARs with stochastic volatilities. In our framework we mainly focus on implication 1 and 2 of the GH, which can be verified from the estimates of the coefficients and from the impulse response functions of the VAR; we also make some interesting considerations on implication 3.

For each country in our sample, we estimate the time varying VAR in (3), in which five variables and one lag have been included in the model.

$$X_t = a_t + B_t x_{t-1} + \varepsilon_t \qquad (3)$$

The vector of variables $X_t' = \begin{bmatrix} \pi_t & y_t^d & y_t^f & \tau_t & i_t \end{bmatrix}$ includes the 4-quarter domestic cpi inflation π_t, the domestic and foreign real output gaps y_t^d and y_t^f, the real exchange rate τ_t and a policy (short term) interest rate i_t. The matrix of coefficients B_t, the intercept term a_t and the variance covariance matrix of the innovations ε_t are allowed to vary over time and are freely estimated by the regression model[8]. The frequency of the data is quarterly and the period sample goes from 1971:1 to 2006:4. Given this ample length, quarterly data provide an adequate amount of observations to estimate these time varying regressions.

The real exchange rate is introduced as a proxy of the import prices used by IEA and BF in their empirical specifications. IEA consider, for example, the deviation of import price inflation from the domestic inflation. The choice of the real exchange rate finds a justification also from a theoretical point of view. In fact the term of trade, a term measuring the deviations of import prices from the law of one price or the real exchange rate are tipically present in the Phillips Curve equation of a new Keneysian model. Our measure of real exchange rate is a perfect empirical counterpart of this variable.

We then compute the impulse response functions of the domestic inflation to structural shocks to the domestic and foreign gap and to the real exchange rate at different points in time, identifying the shocks by a recursive Cholesky scheme. Instead of looking only at the time variation of the coefficients, which is studied by the other papers using more basic subperiod or rolling regressions, we can also statistically evaluate how the shape and significance level of these impulse responses have changed over the sample. The impulse response functions, along with the time varying coefficients and the behavior of the stochastic variances and

[8] Following Primiceri (05), both the standard deviations and the contemporaneous covariances of the structural innovations are time varying. The technical details of the estimation are presented in the next section and in Appendix B.

covariances of the innovations, provide a much more compelling and corroborative analysis of the changes over time of the structural relations between domestic inflation and the other variables included in the VAR.

This approach offers three advantages over the simple univariate model in (1). First of all, it allows for a more structural analysis of the implications of the GH which avoids the issues embedded in BF's specification. Inflation expectations are formed using all the currently available information, they have an important autoregressive component, but all the relevant information contained in the other variables is fully exploited. Furthermore, adding the impulse response functions to the coefficients' analysis can uncover important dynamics otherwise hidden by the simple univariate regressions.

Second, the time varying coefficients VAR is a sophisticated technique specifically designed to capture the time variation properties of the relations among its variables. Given the extreme importance of the time dimension in the GH's implications we are testing, it seems opportune to pursue a more reliable assessment of this aspect.

Third, the model estimates also the changes in the variance covariance matrix of the structural shocks. This accounts for the possible effects of the reduction of the volatility of the shocks, documented by the "good luck - good policy" literature, but it also allows us to combine evidence of the changes in the impulse responses with evidence of changes in the business cycle properties of the variables interpreted through the changes in the simultaneous covariances of the shocks.

Our empirical analysis is enhanced by a new dataset in which accurate and homogeneous measures of the foreign gap and the real exchange rate for each country are constructed. Following the methodology described by Loretan (06) for the construction of the American real exchange rate, we compute a set of trade-based weights for about fifty countries that we use to aggregate pair-wise exchange rates and national output gaps in order to form the real exchange rate and foreign gap of each country. Our dataset improves that of IEA by broadening the definition of the world (i.e. increasing the number of countries) used to construct the weights and by extending the time series to the beginning of the 70's.[9]

The time horizon is a sensitive aspect of the results we obtain. Our data basically cover the post Bretton Woods era, almost four decades characterized by a regime of more flexible exchange rates and the increase in the globalization of the world economy at the heart of the GH intuition. In principle, all the countries used to construct the trade-based weights could also be used to estimate our time varying coefficients VAR, the difficulty of finding consistent series for the short term policy rates going back to 1970 has been the biggest limitation to our analysis so far.

[9] More details about the construction of the data and the sources used are left for the next section and Appendix A.

4 Characteristics of the Dataset and Estimation

4.1 The Data

The first part of the dataset provides the time evolution of the trade shares and trade-based weights that are used to construct the weighted foreign output gap and effective real exchange rates for each country in the sample. The weights are obtained starting from the time series of the pairwise imports and exports flows among a set of about 50 countries which include all the OECD countries, the major Asian economies and some other emerging countries[10]. The flows data come from the IMF-DOT database, we cover the sample 1970:1 through 2006:4 at quarterly frequency.

We calculate the weights following the FED approach to the construction of the effective exchange rate presented by Loretan (06). The weights are meant to provide a measure of the relative importance of an international partner for a country; this is achieved accounting both for the direct relations between two countries, given by the relative share of imports and exports from one country to the other, and for the so-called third-party relations which are used to keep into account the indirect effects due to international competition among countries.

In the second part of the dataset we construct the five variables used in the eighteen TV-VARs. First of all, we put together the domestic output gap for each country in the weights dataset; if the gap is not provided by the OECD National Account Statistics, it is usually constructed as the percentage deviation from the HP filter of the real GDP series taken as a proxy for the potential GDP. The sources for the real GDP are the OECD and the IMF for almost all the countries; the GDP series are first seasonally adjusted. For each of the eighteen countries in our sample, the domestic gaps of all the other countries are then weighted to form the trade-based measure of foreign gap.

The same procedure applies to the construction of the country-specific real exchange rate. The pairwise nominal exchange rates obtained either from the KEYIND database of Global Insight or from the Global Financial Data database are seasonally adjusted, deflated by the CPI indeces of the countries and aggregated using the same trade-based weights.

We compute the inflation rate as the log-difference of the domestic CPI index relative to the same quarter of the previous year, the 4-quarter inflation has been used by BF while IEA prefer to use the quarter-to-quarter inflation in order to reduce the autocorrelation of the residuals of their regressions. The CPI indices usually come from the IMF database or that of the OECD-MEI, the base year is set to 2000 and the series have been seasonally adjusted.

[10]A complete list of the countries can be found in Appendix A. The Appendix defines also the trade-based weights, the formulas applied for the real exchange rate, and describes the sources of the data more in detail.

Finally we take short term deposit and money markets interest rates as policy rates. The main source for these is the Global Financial Data database.

4.2 Time Varying VAR

Let X_t be a $(n \times 1)$ vector containing observations at time t of the macroeconomic variables of interest. In our case $n = 5$ and $X_t = \begin{bmatrix} \pi_t & y_t^d & y_t^f & \tau_t & i_t \end{bmatrix}'$, for example.

In a general case, variables evolve over time following a time varying VAR

$$X_t = a_t + \sum_{p=1}^{P} B_{t,p} X_{t-p} + \varepsilon_t \quad (4)$$

$$\varepsilon_t = \Omega_t^{1/2} \omega_t \quad (5)$$

where a_t is a n-dimensional column vector of intercepts, $B_{t,p}$ is a $(n \times n)$ containing the p-lag time-varying autoregressive coefficients, and $\omega_t \sim N(0, I)$. Note that the variance covariance matrix of the residuals is also time varying. In case of only one lag, $p = 1$ and the model reduces to the equation in (3).

Following Cogley and Sargent (06) and Primiceri (05) amongst others, we postulate a random walk for the evolution of the VAR coefficients:

$$\Phi_t = \Phi_{t-1} + \eta_t \quad (6)$$

where $\Phi_t = [vec(a_t)', vec(B_{t,1})', ..., vec(B_{t,p})']'$.

The covariance matrix of the VAR innovations Ω_t is factored as

$$VAR(\varepsilon_t) \equiv \Omega_t = A_t^{-1} H_t (A_t^{-1})' \quad (7)$$

The time-varying matrices H_t and A_t are defined as:

$$H_t \equiv \begin{bmatrix} h_{1,t} & 0 & ... & 0 \\ 0 & h_{2,t} & ... & 0 \\ ... & ... & ... & ... \\ 0 & 0 & ... & h_{n,t} \end{bmatrix} \quad (8)$$

$$A_t \equiv \begin{bmatrix} 1 & 0 & 0 & ... & 0 & 0 \\ \alpha_{2,1,t} & 1 & 0 & ... & 0 & 0 \\ \alpha_{3,1,t} & \alpha_{3,2,t} & 1 & ... & 0 & 0 \\ ... & ... & ... & ... & ... & ... \\ \alpha_{n-1,1,t} & \alpha_{n-1,2,t} & \alpha_{n-1,3,t} & ... & 1 & 0 \\ \alpha_{n,1,t} & \alpha_{n,2,t} & \alpha_{n,3,t} & ... & \alpha_{n,n-1,t} & 1 \end{bmatrix} \tag{9}$$

with the $h_{i,t}$ evolving as geometric random walks,

$$\ln h_{i,t} = \ln h_{i,t-1} + u_t$$

Following Primiceri (05), we postulate that the non-zero and non-one elements of the matrix A_t evolve as driftless random walks,

$$\alpha_t = \alpha_{t-1} + e_t \tag{10}$$

and we assume that the vector $[\varepsilon_t', \eta_t', u_t', e_t']'$ is distributed as

$$\begin{bmatrix} \varepsilon_t \\ \eta_t \\ u_t \\ e_t \end{bmatrix} \sim N(0, V), \tag{11}$$

$$V = \begin{bmatrix} \Omega_t & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & G & 0 \\ 0 & 0 & 0 & S \end{bmatrix} \text{ and } G = \begin{bmatrix} \sigma_1^2 & & \\ & \ddots & \\ & & \sigma_n^2 \end{bmatrix} \tag{12}$$

The VAR is then estimated using the Bayesian methods described by Kim and Nelson (99). In particular, we employ a Gibbs sampling algorithm that approximates the posterior distribution of the model (see Appendix B for details). The priors and the starting values for the VAR coefficients are based on a fixed coefficient VAR estimated over the first 24 quarters of the sample.

5 The results

This section presents a set of descriptive empirical evidence derived from our VAR estimates in order to assess the GH implications for inflation and the Phillips Curve. We study eighteen Western countries and emerging economies and a large variety of sizes and degrees of openness is represented. The aim of this section is to provide a possible interpretation of the results in terms of the differences in the structural characteristics of the systems. The countries we analyze are: US, UK, Germany, France, Italy, Spain, Ireland, Denmark, Netherlands, Austria, Switzerland, Canada, Mexico, Australia, Japan, Korea, South Africa, and New Zealand.

5.1 Evidence from the Reduced Form Phillips Curve

We first check the behavior of the coefficients of the π-equation of the VAR, since this equation is our reduced form equivalent version of the Phillips Curve in (1). In this case it reads

$$\pi_t = c_t + \eta_t \pi_{t-1} + \beta_t y^d_{t-1} + \delta_t y^f_{t-1} + \gamma_t \tau_{t-1} + \theta_t i_{t-1} \tag{13}$$

Figure 4, 5, and 6 show the time variation of β_t, δ_t and γ_t for the countries in the sample. These three coefficients refer to the three implications of the GH as directly tested by BF and IEA regressions.

The theory suggests that β should be positive, but small and decreasing over time. This is true in Figure 4 only for Germany, UK, Italy, and Japan; it is marginally significant and quite flat for US, Canada, Korea, and New Zealand; it is never significantly different from zero for all the other countries[11].

On the other hand, Figure 5 shows that δ is positive and significant only for three countries: Austria, Spain, and Denmark; and marginally significant for Australia, Korea, Ireland, Italy, New Zealand, and South Africa. However, it is generally not increasing for the countries in our sample. At the end, only Austria and Spain support the second implication of the GH.

The GH is not supported at all by these two sets of graphs, Table 2 recapitulates these results. As in IEA, we can say the foreign gap does not play a significant role and the second hypothesis holds only in two cases. Even in those countries like Italy, Ireland, France, Japan, or Denmark in which δ was significant at the beginning of the sample, the importance of the foreign output gap diminishes over time.

However, we find that the domestic gap is still quite important for half of the countries we analyze, with median estimates of β between 0.1 and 0.2 which are not so far from the New Keynesian models' theoretical values we saw in Section 2. Milani (09) estimates a structural model for the G7 economies (all included in this sample too) and he obtains results qualitatively in line with our estimates, even though the estimates of his coefficients are alway smaller by a factor of ten.

With the exception of Germany, the domestic gap is currently not significant only for those countries in which it was not significant already in the 80's. This must be interpreted more as a lack of a meaningful

[11] It has actually the wrong sign for Austria, Ireland and Spain.

relation between inflation and output gap, rather than as an effect related for any reason to the degree of internazionalization of the economy. It is interesting to notice, also, how the countries with a more significant δ, generally do not have a significant β. This again cannot be related to globalization per se, but it is more likely dependent on the specific characteristic of each economy.

The third implication of GH is studied in Figure 6 which presents the estimates of γ. The definition of real exchange rate we use implies that a decrease of RER corresponds to a devaluation; according to the GH δ should then be negative and increasing in absolute value. Even though δ is mostly of the right sign or not significant, it is difficult to find a common pattern in its time evolution across countries. Only Germany and France and, to some extent, New Zealand respect the prediction of the GH.

Our results so far reject the GH and we can consider them in line with the conclusions of IEA; the TV-VAR approach however provides a few other valuable pieces of information which complete this picture and make it less certain. We turn now to the analysis of the stochastic volatilities and covariances of the reduced form innovations of the VAR and to the impulse responses of the variables of the model to the structural shocks in the next section, in particular looking at the responses of national inflations to domestic and foreign gaps.

A standard result in the "good luck - good policy" strand of the monetary policy literature finds that the volatility of the inflation and policy shocks have been decreasing in the last two decades[12]. The declining variability of the inflation rate may raise some concern about the possibility of estimating any effect for the domestic and foreign gap in the Phillips Curve at all when adaptive expectations are used. The full specification in IEA completely nulls the foreign gap coefficient δ; the drawback, however, is that it very often neutralizes any attempt to identify β too. Here this kind of problem is less evident, as the results in Table 2 show.

Using the four quarter inflation, one lag and controlling for the policy rate in the reduced form of the VAR allows us to keep the definition of inflation of BF and, at the same time, proposes a simple, but sensible, specification similar to the one used by IEA which manages to preserve the fundamental role of the domestic gap while providing evidence against the GH. The estimates of the fix-coefficients version of the national VARs for the whole sample show that this specification generally produces slightly autocorrelated residuals for the inflation equation, mostly at the first lag, but the overall lag structure of the VAR does not seem implausible at all. It would be interesting to consider at least one more lag in the specification of the VAR, which would be a straightforward extension of our procedure and would simply require some extra computational effort.

[12] The graphical output for the volatilities is not reported in this paper for sake of brevity. It is available on request from the authors.

5.2 Structural Evidence

The advantage of using a VAR approach instead of a plain univariate regression is that we can make some considerations on the structural relations among the variables in the VAR. The key intuition is that even though the reduced form Phillips curve does not support the GH implications, changes in those relations might be disclosed, for example, by the impulse responses of inflation to the structural shocks to domestic and foreign gaps. Once the analysis is shifted to the structural part of the model, the conclusions which can be drawn are less unambiguous and agree more, in some sense, with the mixed evidence presented by BF.

5.2.1 Identification Scheme

A natural way to map implication 1 and 2 of the GH into the impulse response functions is to associate the response of inflation to a domestic gap shock to the predictions for β and the response of inflation to a foreign gap shock to the predictions for δ. Obviously, the results we obtain may depend on the particular specification chosen to identify the structural shocks. The way we proceed to identify the structural VAR is based on the following observations.

First of all, we rely only on Cholesky recursive decompositions of the reduced form variance covariance matrix Ω_t of the VAR residuals. The Cholesky decomposition is usually regarded as a convenient way to implement and estimate the structural VAR starting from the reduced form estimates. However, in this case, this choice is not simply driven by convenience, it is actually deeply related to the technical features of the time varying estimation procedure, because in some cases it may turn out to be difficult to match feasible identification schemes with the Ω_t estimated by the model. The high flexibility of the the time varying model, on one hand, can come at this cost.

To illustrate this issue, suppose we believe, based on some economic reasoning, that two variables in our model should not affect each other on impact and want to use this insight to impose two of the restrictions of the identification scheme. We would have to place two symmetric off-diagonal zero elements in the decomposition matrix for the contemporaneous covariances of those two variables, which would also force those two zeros to appear in the same positions in the corresponding structural variance covariance matrix. This structural identification would be compatible with the time varying estimates of Ω_t only if it happens to have very small values in the corresponding positions of those symmetric zero restrictions. Obviously, this is not going to hold in general for every posterior draw of Ω_t, but it can lead to high rejection rates of the identification scheme which, in such a case, would make the identification empirically unlikely or questionable.

This actually happens here to what we considered the preferable specification of the identification scheme.

We would be inclined to consider the foreign output gap as a quite exogenous variable for a country's economic system. Therefore, it would be reasonable to assume a lag in the transmission of the domestic inflation and the domestic output gap shocks to it and, vice versa, of its shocks to these two variables. This strategy determines a (almost) diagonal block for these three variables as represented in Table 3, where inflation is assumed to respond on impact to the domestic gap and the real exchange, and this latter variable and the interest rate fully respond to anything else. The rest of the scheme is based on assumptions that will be explained next.

Our estimates seem to be in odds with the scheme in Table 3. One could think of relaxing part of the assumptions by moving, for example, the element in position $(1,4)$, or even in position $(4,5)$, to $(1,3)$ in order to mitigate the problem, therefore allowing the inflation rate to respond to the domestic and foreign gap. Another remedy could be to allow the domestic gap to respond to the foreign gap, but not the other way around; however, it is easy to see how all of the proposable remedies would make any ad hoc specification closer to a more standard and simpler Cholesky scheme. Therefore, we eventually opt for a Cholesky decomposition, which seems to be a more reliable identification approach for the time varying models given our data.

Second, we must decide the ordering of the variables in the Cholesky decomposition. We start separating the interest rate i and the real exchange rate τ from the other three real variables. The policy rate is normally ordered as last in the VAR literature for the analysis of the monetary policy, this is used as an identification assumption to isolate the monetary shocks. It is assumed that the interest rate does not affect output and inflation in the same period, while at the same time it is able to respond on impact to them. We follow Primiceri (05), Leeper, Sims and Zha (96), Christiano, Eichenbaum and Evans (99) among others in this. Being essentially a financial variable free to adjust continuously, it seems relative safe to order the exchange rate as fourth. The correct relative position of these two variables is hard to define a priori, it would again depend on the monetary policy characteristics of a country. For a country with a central bank concerned with stabilization of the exchange rate, as for example smaller and export oriented economies, i should be ordered as the last variable; for bigger and closer countries, as, for example, the US, it could be more reasonable to order τ last. We must notice this does not really matter for the impulse response functions of π to the output gaps, which is what we are mainly interested in during this analysis, and we keep i in the last position in our applications.

We turn then to the relative order of the three real macro variables: the inflation rate π and the two output gaps y^d and y^f. As we said, it is quite reasonable to assume the foreign output gap is less responsive to the domestic variables than the domestic gap is to the foreign output gap. This is definitely true for a small open economy, and this basically refers to most of the countries in our sample; it might be less true for large economies such as the US, but it turns out that the impulse responses of inflation to foreign gap shocks are generally less sensitive to the ordering for those large countries. In terms of identification assumptions, these observations lead us to consider orderings in which y^f comes before y^d.

The last crucial element of the identification at this point is the relative position of π. Primiceri (05) uses the same time varying VAR model to study a small macro model for the US monetary policy. He includes only π, y and i in his VAR and considers the relative ordering of π and y as a normalization once the monetary shock has been identified. He is interested in the responses of the variables to policy shocks and claims that his results are not affected by the specific choice about the ordering. Following his work, we notice that the relative position of π and y^d does not actually introduce significant differences in the responses of inflation to the domestic output gap shocks either.

In conclusion of this section, we therefore propose two main identification schemes that can be seen as the two extremes of the set of sensible identification strategies outlined above. The first ordering of the variables is $\left(y^f\ y^d\ \pi\ \tau\ i\right)$. Since the main focus of this paper is to study the responses of π to the output gaps shocks, this can be considered a conservative choice because it does not constrain the impact responses of the inflation to be zero. This resembles very closely the typical identification strategy used by Peersman and Smets (03) to study the monetary policy transmission in the European Union. They treat the foreign output as an exogenous variable, while we keep it as endogenous in the VAR, and they prefer to order the exchange rate last. This is a good assumption for Europe, but not in general for smaller economies. In fact, Mojon and Peersman (03) adopt our specification when studying the transmission inside single countries of the Union.

The second main specification we take is $\left(\pi\ y^f\ y^d\ \tau\ i\right)$, in which π is listed first and all the rest is the same. This specification is justified by the idea that the transmission of a shock from country to country can take place with some delay. This is the most interesting alternative option from our point of view, since moving π between y^d and y^f basically generates the same outcomes as the first specification and there is no particularly valid reason for assuming that inflation does not contemporaneously respond to the domestic output gap, on the one hand, while responding to the foreign gap, on the other. Finally, we will also try the same analysis under other specifications to provide a robustness check of our results; our two main identifications basically encompass the other possible variants.

5.2.2 The impulse response functions and the GH

For simplicity, we start this section describing the output we are going to use to present the empirical results.

Figure 8 and 9 are based on the first identification strategy $\left(y^f\ y^d\ \pi\ \tau\ i\right)$ and they show, respectively, the responses of inflation to a unit shock to the domestic and foreign output gap. The graphs of the responses are illustrated country by country for the years 1986, 1996 and 2006[13]. The functions are shown for sixteen quarters: the solid lines are the median response, while the dashed bands are the $14th$ and $86th$ percentiles of the posterior distribution of the responses. Figure 10 and 11 repeat the same output for the second specification $\left(\pi\ y^f\ y^d\ \tau\ i\right)$.

Figure 7 presents the time evolution of the correlation of the reduced form residuals of the y^d and y^f equations. This is combined with the impulse response functions of y^d to shocks to y^f of Figure 12 and the sample correlation of the domestic and foreign gap in Table 4 to study the international integration of national business cycles[14]. Table 5 describes the change in the degree of openness of the countries in our sample, measured as the ratio to GDP of the sum of imports and exports. We report the average ratio by half-decade since 1980 to 2006 and the change in openness over the period. Figure 13 shows the impulse response functions of inflation π to the real exchange rate τ and, finally, Figure 14 shows the evolution of the variance decomposition of inflation based on the ordering of the variables in the two main identifications. The mean contribution of each variable is reported for each quarter, the first two and lightest surfaces coming from the top of each individual box correspond to the contribution of y^d (the lightest) and y^f (the second lightest).

Overall Outlook.

The responses of inflation to the domestic output gap are positive and significant for half of the countries and the rest of them are quite flat and not significant. A flattening of the profile of these functions is not observable. Turning to the responses to the foreign gap shocks, we see a consistently positive and significant response of inflation across countries and across periods. However, once more, there is no particular change in the profile of the curves over time. The results do not qualitatively differ from one identification to the other, except for Austria, Australia, Netherlands, and South Africa, which show a negative response to the domestic output gap shock under the first identification which is quite hard to reconcile with theory.

Even though, as we have seen, the δ coefficients in the Phillips Curve are not usually significant, the impulse response functions emphasize the structural role of the foreign output gap. This is not negligible at all and it is only slightly smaller than that of the domestic output gap. This is perfectly in line with the theoretical implications of the open economy New Keynesian models discussed in section 2 and, actually, even larger than what predited for standard calibrations having the two responses the same magnitude. The responses of inflation to the real exchange rate are negative and significant, except for UK, Australia, Spain, and Denmark which have positive responses. The responses, however, are definitely smaller.

Nonetheless, the time pattern of the change in the relative importance of the two output gaps, which is

[13] We pick the first quarter of 1986 and 1996 and the last quarter of 2006, which corresponds to our last observation.

[14] The impulse responses in Figure 12 and 13 have the same features as those in Figure 8 and 9. They are based only on the first specification, being the results for the second very similar to these.

a crucial prediction of the GH, is completely missing. It is clearly missing from the impulse responses and it is not evident from the variance decomposition of π either, except for a few countries. The point is that this prediction is derived from the normally accepted view that integration and openness have pervasively increased over time in the past decades. A closer look at the data in Table 5 reveals that the countries which were substantially open already three decades ago are still the most open, while less open countries are remained quite closed. The same idea is coveyed by the evolution of the variance decomposition of inflation in Figure 16, where the share of the variance explained by the foreign gap shocks basically does not change over time. The lack of time variation in these impulse response functions and in the variance decompositions can be interpreted as evidence of a substantial lack of change in the degree of openness of the countries we study.

We can draw an important conclusion from this evidence. The level of openness which has characterized the world economy since the 70's has been enough to make the foreign gap matter for the macroeconomic dynamics of inflation for many countries in our sample, however, increases in openness by only about five percentage points have not been enough to change the economic structures of these countries.

Is this a failure of the GH? We would not say so. It seems now quite clear that the idea of GH adopted in previous works empirically fails. We point out at the same time, however, that this failure is most likely related to the excessive emphasis put on an increase in openness which has not actually been that large. Nevertheless, we show that globalization systematically affects the dynamics of domestic inflation through its responses to the foreign output gap shocks and this leaves on the table the unresolved question of what could happen in the future under the thrust of a stronger globalization.

A unified interpretation of our results is difficult to find. The factors that explain the differences among countries, in particular when we take into account the structural aspects of the economy, can be numerous and range from the business cycle integration with the world output gap, to the degree of openness, to the monetary policy set up. We proceed then with comparisons of countries in smaller subgroups, which allows us to highlight some common patterns while controlling for similar characteristics of the countries.

Four Large Economies.

We compare first the four largest economies in our sample: US, UK, Japan and Germany. These nations are economic leaders in their own geographic areas, they have comparable sizes (even though the US is definitely larger) and they conduct quite independent monetary policies. However, their degree of openness is very different because we can consider Japan and US relatively closed economies, while UK and Germany are undoubtedly more open[15]. The behavior of β and δ is the same for all four of these countries: β is

[15] UK and Germany are average countries in terms of opennes in our sample. It is important to stress again the fact that for none of these four countries the openness index has particularly increased. The 10% improvement of Germany is the largest increase among them and the index does not increase at all for Japan and UK.

positive and significant, δ is positive, but smaller and generally not significant. We can also observe that, in general, the response of inflation to domestic output gap shocks is more pronounced than the response to the foreign gap in all of the countries, as predicted by the theoretical models, and that the response to the foreign gap is consistently more significant in UK and Japan. This can be linked to the higher degree of openess of the UK, even though only weakly, since this explanation would not hold for Germany (as open as UK) and Japan (quite closed). However, it seems to be somehow related to how the domestic business cycles comove with the global cycles.

In fact, both Japan and UK show smaller correlations of their domestic output gap with the respective global gaps compared to Germany and US, smaller and less significant responses of y^d to shocks to y^f and smaller correlations in the reduced form VAR residuals of these two variables[16].

European Countries.

We have eight European countries besides UK and Germany: France, Italy, Spain, Denmark, Ireland, Austria, Netherlands, and Switzerland. Seven of them are in the Monetary Union and we also include Switzerland because of its economic proximity to the rest of Europe. All these economies are actually very similar in many respects. They are quite open or very open, their openness ratios for the last five years range between 0.4 and 1.10, and have experienced a mild increase of ten percentage points since the beginning of the sample in the openness ratios. They share the same international economic environment, since their Rest of The World is mostly defined by Europe itself, and they are characterized by a good business cycles international coordination since all the countries, with the exception of Ireland, show a high correlation between gaps and in their VAR residuals too. In terms of the impulse response functions of inflation, these countries do not seem to have had particularly significant responses to the domestic gap; Italy shows the only different behavior and its response for 2006 definitely becomes flatter. However, the responses to the foreign gap shock are often positive, nicely hump-shaped, and significant, with the significance declining for the last observation. The process of creation of the common currency area that has involved the European countries has naturally shaped their international dimension.

We also observe a quite interesting inverse relation between the response of the domestic output gap to the foreign gap shocks, on one side, and the response of inflation to the same shock on the other. For example, when the response of y^d in Italy and Switzerland became more pronounced in 2006, the response of π became flatter. The same was observed comparing UK and Japan to US and Germany. The domestic output gap works as a diaphragm in the transmission of the y^f shocks to the inflation rate.

Small open economies.

[16] For UK, it starts at a quite large value comparable to US, but then it falls in the second half of the sample below 0.2. This seems to be a particularly sensitive threshold for our results.

The last group we consider is composed of small and quite open economies. We have: Canada, Australia, Mexico, South Africa, New Zealand, and South Korea. In this group Canada departs form the others because of its extremely tight relations with the US economy. We can see it from the large correlation of its domestic output gap with its foreign counterpart and the correlation of the VAR residuals of the two output gaps. So we should think of the link between Canada and US in the same way as we think of the relation among European countries, between Italy and Germany for example. The other countries show very small sample correlations (between 0.05 and 0.36) and basically no residuals' correlation.

In general the response of π to the domestic output gap shock is smaller and less significant than the response to the foreign gap shock; the foreign gap plays a very important role for this small economies[17]. Finally, also for this group of countries, we observe the negative relation between the response of π and y^d to the shocks to y^f already documented for the other countries.

Summary of the Comparisons.

The structural role of the foreign output gap shocks, at which we look through the response functions of domestic inflation to the two output gap shocks, seems to depend on two factors. First, it is positively related to the degree of openness of a country. Second, it is positively related to the degree of idiosyncrasy of the domestic business cycles, which we have analyzed taking into account the correlation between domestic and foreign output gaps and the response of the domestic output gap to the foreign gap shocks. Neither of the two factors absolutely dominates the other. For the European countries, for example, a very high degree of opennes offsets the tight economic links among them. In the case of Japan, the large idiosyncrasy makes up for the limited openness of the country.

6 Conclusions

The goal of this paper is to empirically assess whether the implications of the globalization hypothesis for national inflations are supported by data. In order to improve the standard univariate regressions of the Phillips Curve used so far in literature, we estimate time varying coefficients VAR's for a broad set of eighteen countries, using a homogenous and quite long dataset covering the past four decades from 1970 to 2006.

So far, mixed evidence has been provided by previous works and, in particular, the debate has been enlivened by the opposite conclusions reached by Borio and Filardo (07), who are in favor of the GH, and Ihrig et al. (07), who are against it. Our aim is to contribute to the debate shifting the focus on a more structural approach and providing a more corroborative analysis of this issue.

[17] The exception is New Zealand, which behaves in the opposite way. Notice also that the results for Mexico are difficult to interpret because quite erratic; we would expect it to be more similar to Canada, given its close links with US too, but this is not the case.

So the big question at this point is: Has the GH passed the test? Or, putting it in another way, on which side of the debate does this paper lean? We articulate the answer to this question in three parts, since a simple straight answer would not do justice to our conclusions.

First, looking at the standard definition of GH as tested by BF and IEA, our results support the conclusions in IEA. The coefficient of the domestic output gap (β) in the Phillips Curve has, in general, become smaller or been stable in the sample and it is often not very significant. However, this has not come along with a progressive increase in the importance of the foreign output gap as the behavior of its coefficient (δ) shows. Furthermore, even if the sign of the coefficient of the real exchange rate (γ) is correct, we do not observe any particular time pattern consistent with the GH. So, from this point of view, the GH fails.

Second, the structural evidence shows that even though the reduced form coefficients of the foreign gap are null, the foreign gap definitely has a significant role at structural level. This conclusion is robust across specifications of the identification scheme in our sample except for a few countries. These indirect effects can be singled out only by structural considerations and, therefore, were completely missing from the previous literature. We do not observe, however, the increase in the relative importance of the foreign output gap over the last three decades that the full GH would imply under the assumption of an increase in globalization. In fact, the lack of time variation in the response functions of π to the shocks to the foreign output gap and in the portion of variance explained by these shocks, in the decomposition of the variance of π, are associated to a mild increase in the degree of openness measured by the ratio to GDP of the sum of imports and exports of our countries. This suggests that it is premature to test for the GH until it is clear a more substantial shift in the integration of the world economies has occured. However, the importance of the role of Globalization for the national macroeconomic outcomes is definitely reinforced by these results.

Third, the comparison across similar countries allows us to highlight some regularities in the effects of greater openness and interdependence of the global business cycles on the GH. The structural contribution of the foreign output gap shocks to the dynamics of inflation is usually more conspicuous the greater is the degree of openness of a country and the smaller is the correlation of its output gap with the foreign business cycles. We also observe that the response of the domestic output gap to the foreign gap shocks works as a screen in the transmission of the these shocks to the the inflation rate. We can conclude that higher idiosyncrasy of the domestic business cycles increases the exposure of inflation to the foreign output. However, a good degree of openness facilitates a prominent role of the foreign output gap, even when the international integration is deep, as, for example, is the case for the European countries and for Canada with US.

Appendix

A The Dataset

This Appendix provides further details on the data sources and the elaboration we applied in this work. For the sake of exposition, only the most important features of them are presented here. A more complete description of the procedures followed and of country specific particularities is given in the note "The construction of a global trade-based dataset" which is available, along with all the matlab codes necessary to construct the database and described in the note, from the authors' webpage.[18]

A.1 Countries

We run the TV-VAR for eighteen countries: US, UK, Germany[19], France, Italy, Spain, Ireland, Denmark, Netherlands, Austria, Switzerland, Canada, Mexico, Australia, Japan, Korea, South Africa, New Zealand.

The countries included in the sample for the trade-based weights are: Belgium, Luxembourg, Norway, Sweden, Finland, Greece, Iceland, Portugal, Turkey, Yugoslavia (Croatia and Slovenia after 1993), Argentina, Brasil, Colombia, Peru, Venezuela, Israel, Hong-Kong, India, Indonesia, USSR (Russia, Latvia and Lit huania after 1993), China, Czechoslovakia (Czech Republic and Slovakia after 1993), Hungary, Poland. The eighteen countries listed above are also included in this list.

A.2 Weights and other formulas

The formula for the imports, exports and third party weights (w^m, w^x, and w^3 respectively) are the following:

$$w^m_{i,j,t} = \frac{M_{i,j,t}}{\sum_{j=1}^{N_t} M_{i,j,t}}$$

$$w^x_{i,j,t} = \frac{EX_{i,j,t}}{\sum_{j=1}^{N_t} EX_{i,j,t}}$$

$$w^3_{i,j,t} = \sum_{k\neq j,\neq i}^{N_t} w^x_{i,k,t} \frac{w^m_{k,j,t}}{1 - w^m_{k,i,t}}$$

where $M_{i,j}$ and $EX_{i,j}$ are imports from country j to country i and exports from country i to country j. The presence of N_t allows for time varying size of the pool of countries. The weights are finally aggregated

[18] Link to www.princeton.edu/~acivelli

[19] East Germany is added to Germany after the 1992 unification.

as in (14)

$$w_{i,j,t} = 0.5w^m_{i,j,t} + 0.5\left(0.5w^x_{i,j,t} + 0.5w^3_{i,j,t}\right) \tag{14}$$

The real exchange rate indices $\hat{I}_{i,t}$ for country i at time t are obtained by combining these weights with the pairwise exchange rates. We follow Loretan (05) and apply the next formula

$$\hat{I}_{i,t} = \hat{I}_{i,t-1} \prod_{j=1}^{N_t} \left(\frac{\hat{e}_{i,j,t}}{\hat{e}_{i,j,t-1}}\right)^{w_{i,j,t}}$$

The real exchange rate between country i an j is $\hat{e}_{i,j,t}$

$$\hat{e}_{i,j,t} = e_{i,j,t}\frac{P_{i,t}}{P_{j,t}}$$

where $P_{i,t}$ is the CPI level of county i at period t and $e_{i,j,t}$ is the nominal exchange rate between country i and j expressed as the price of one unit of currency i in terms of unit of currency j. So $\hat{e}_{i,j,t}$ can be defined as the value (or the price) of country i basket good in terms of country j basket. Currency i (good i) becomes more valuable relative to its j's counterpart when $e_{i,j}$ ($\hat{e}_{i,j}$) increases and they devaluate when they decrease.

Whenever an official output gap measure is not available, the real GDP series is first passed through a HP filter which defines our potential output for that country; we then compute the gap for country i as percentage deviation of the GDP from the potential

$$gap^i_t = \frac{gdp^i_t}{pot^i_t} - 1$$

The relevant foreign output gap for country i is simply computed as a weighted average of the domestic outputgap of all the other countries in the sample.

A.3 Sources

The main sources for the data in this work are the OECD National Accounts Statistics (NAS) and Economic Outlook (EO), the OECD Main Economic Indicators (MEI), Global Insight (GI), and Global Financial Data (GFD).

Trade Flows. For all countries and throughtout the entire sample the IMF Direction of Trade (DOT) provides the pairwise trade flows among the countries in the sample. The data are available for the sample 1970:1 to 2006:4, but then it is reduced to 1970:1 to 2006:4 when working with GDP data and other series due to the shorter availability of most of these series. The flows are measured in current US Dollar for all the countries, so that they are reliably comparable. Notice that DOT treats Belgium and Luxembourg as separate countries only after 1997 and that Germany is defined as only West Germany before the 1991 reunification. We necessarily keep the same definitions for the other data too.

Real GDP. EO provides the output gaps for eight countries: US, UK, Canada, Australia, France, Germany[20], Italy, and Japan. It seems that the OECD follows a procedure very similar to ours to construct its output gaps because its measure and ours coincide a lot for these countries. For the other countries, the real GDP series are used as explained in the previous section. The series are generally already seasonally adjusted, but, if not, we apply Census x12 to them. NAS covers all the OECD countries for the entire sample: Denmark, Netherlands, Norway, Sweden, Switzerland, Canada, Japan, Finland, Greece, Iceland, Ireland, Portugal, Spain, New Zealand, Mexico, Honk-Kong, Korea, Belgium, Luxembourg, South Africa, and Austria[21]. The other countries require more elaboration and different sources (GFD and Datastreamare in particular) are combined to get the most consistent measure of GDP for the longest possible period. Time limitation is the main problem in these cases, with series of the emerging countries and youngest nations starting only in the late 80's. It is worth noticing here that Yugoslavia, USSR and Czechoslovakia must be dropped from the output gap sample for lack of data. For their recent importance in the world economy China and India are mantained for the all sample even though their quarterly data start only in the 90's, a fitting on the annual data is implemented. The source for Chinese data is China Marketing Research Co.

Nominal GDP. The nominal GDP data are necessary only to compute the measure of openness of the country presented in Figure 3 and Table 5, since the trade flows are expressed in Dollars. So we cover a much narrower sample of countries. However, given the real GDP series, the CPI and the exchange rates, we can construct the nominal series in Dollar for most of the countries in the larger sample. Comparison with OECD_MEI and GFD data confirm the reliability of these series.

Nominal Exchange rates. We use the US dollar as pivotal currency for the bilateral exchange rate between US and the other countries in the sample, this allows the creation of a pairwise dataset for each country. The main sources of these series are the KEYIND base of GI and the GFD web base. The data are originally reported as units of a currency necessary to buy 1 US dollar and we express every exchange rate as unit of foreign currency necessary to buy 1 unit of domestic currency. To avoid shifts of definition in the accounting unit of the numeraire, we use as a basic unit for all the exchange rates the last monetary unit used by each country. If this is not possible, because of a change in both the unit and the political definition of a country, we will adopt ad hoc solutions. All the exchange rate series to the dollar are seasonally adjusted by Census

[20] Only after the unification. For the years before 1992 the West Germany gap is used.
[21] Austria requires an integration with data from GFD.

x12[22]. The countries members of the EU switch to the common currency in 1999.

CPI. We set 2000 as the base year, the average of the indices at that year must be 100. The series are mainly from IMF (through GI), OECD_MEI is the main alternative source and some are from GFD too. We seasonally adjust them using Census x12; this adjustment is sensitive only for few of the countries from GFD. In particular, Germany and US, Slovakia and Czech Republic, Brasil, Hungary, and Poland are from MEI, while the Russian Repubblics, Slovenia, Croatia, and Hong Kong are from GFD. China needs again a special treatment, since 1987 a mixed of MEI and China Marketing Research Co data is used at quarterly frequency; before that we use annual figures for CPI as we did for GDP.

Interest Rates. Interest series turn out to be the most challenging part of the dataset to construct. The problem is not the availability of suitable series, but the fact that most of the observations start only since the 80's. For this reason, we focus our attention only on the eighteen countries of the VAR analysis. We select and construct series following two criteria. First of all, short term interest rates are required. So, when possible, we take 3 months treasury bill yields. If this type of series is not available for a country, we usually take a short term interbank or deposit rate. We obviously prefer continuous and homogenous series, however, in some cases we had to merge together more than one series in order to span the entire sample, in particular for the earlier years. GFD is the most useful source for this variable. Treasury bill rates are used for for Japan, US, UK, France, Germany, Australia, Canada, Italy, Belgium, Netherlands, Ireland, and South Africa. Interbank rates are used for Switzerland, Korea, Denmark, Mexico, and Spain. A mixed series is used for Austria and New Zealand.

B Time-Varying Model

The reader can make reference to Bianchi et al. (10) for more details about the estimation procedure of the time varying VAR model.

B.1 Priors

VAR coefficients

The prior for the VAR coefficients is obtained *via* a fixed coefficients VAR model estimated over the sample 1970:1 to 1977:1. Φ_0 is therefore set equal to

$$\Phi_0 \sim N(\hat{\phi}^{OLS}, V^{OLS})$$

[22] These shifts in definition are typical for emerging economies and the new nations founded during the 90's. The note online provides a full description of them.

Elements of H_t

Let $\hat{v}^{ols}$ denote the OLS estimate of the VAR covariance matrix estimated on the pre-sample data described above. The prior for the diagonal elements of the VAR covariance matrix (8) is as follows:

$$\ln h_0 \sim N(\ln \mu_0, I_n)$$

where μ_0 are the diagonal elements of $\hat{v}^{ols}$.

Elements of A_t

The prior for the off diagonal elements A_t is

$$A_0 \sim N\left(\widehat{\alpha}^{ols}, V\left(\widehat{\alpha}^{ols}\right)\right)$$

where $\widehat{\alpha}^{ols}$ are the off diagonal elements of $\hat{v}^{ols}$, with each row scaled by the corresponding element on the diagonal. $V\left(\widehat{\alpha}^{ols}\right)$ is assumed to be diagonal with the diagonal elements set equal to 10 times the absolute value of the corresponding element of $\widehat{\alpha}^{ols}$.

Hyperparameters

The prior on Q is assumed to be inverse Wishart

$$Q_0 \sim IW\left(\bar{Q}_0, T_0\right)$$

where $\bar{Q}_0$ is assumed to be $var(\hat{\phi}^{OLS}) \times 10^{-4}$ and T_0 is the length of the sample used for calibration.

The prior distribution for the blocks of S is inverse Wishart:

$$S_{i,0} \sim IW(\bar{S}_i, K_i)$$

where $i = 1...n$ indexes the blocks of S. $\bar{S}_i$ is calibrated using $\hat{a}^{ols}$. Specifically, $\bar{S}_i$ is a diagonal matrix with the relevant elements of $\hat{a}^{ols}$ multiplied by 10^{-3}.

Following Cogley and Sargent (06), we postulate an inverse-Gamma distribution for the elements of G,

$$\sigma_i^2 \sim IG\left(\frac{10^{-4}}{2}, \frac{1}{2}\right)$$

B.2 Simulating the Posterior Distributions

Time-Varying VAR

The model is a VAR with drifting coefficients and covariances. This model has become fairly standard in the literature and details on the posterior distributions can be found in a number of papers including Cogley and Sargent (06) and Primiceri (05). Here, we describe the algorithm briefly.

VAR coefficients Φ_t

The time-varying VAR coefficients are drawn using the methods described by Kim and Nelson (99).

Elements of H_t

Following Cogley and Sargent (06), the diagonal elements of the VAR covariance matrix are sampled using the methods described by Jacquier et al. (04).

Element of A_t

Given a draw for Φ_t the VAR model can be written as

$$A_t\left(\tilde{X}_t\right) = H^{1/2}\omega_t$$

where $\tilde{X}_t = X_t - a_t - \sum_{p=1}^{P} B_{t,p}X_{t-p} = \varepsilon_t$ and $Var\left(H^{1/2}\omega_t\right) = H_t$. This is a system of equations with time-varying coefficients and given a block diagonal form for $Var(\varepsilon_t)$ the standard methods for state space models described by Kim and Nelson (99) can be applied.

VAR hyperparameters

Conditional on X_t, $\phi_{l,t}$, H_t, and A_t, the innovations to $\Phi_{l,t}$, H_t, and A_t are observable, which allows us to draw the hyperparameters—the elements of Q, S, and the σ_i^2—from their respective distributions.

References

[1] Ball L. (2006), "Has Globalization Changed Inflation?", NBER Working Peper 12687.

[2] Bernanke B. (2007), "Globalization and Monetary Policy", Speech at the Fourth Economic Summit, Stanford Institute for Economic Policy Research, March.

[3] Bianchi F., H. Mumtaz and P. Surico (2010), "The Great Moderation of the Term Structure of U.K. Interest Rates", *Journal of Monetary Economics,* Forthcoming

[4] Borio C. and A. Filardo (2007), "Globalisation and Inflation: New Cross-Country Evidence of the Global Determinants of Domestic Inflation", Bank of International Settlements Working Papers, no. 227.

[5] Calza A. (2008), "Globalisation, Domestic Inflation and Global Output Gaps: Evidence from the Euro Area", European Central Bank Working Paper No. 890.

[6] Clarida R., J. Gali and M. Gertler (2002), "A Simple Framework for International Monetary Policy Analysis", *Journal of Monetary Economics 49*, pp. 879-904.

[7] Ciccarelli M. and B. Mojon (2009), "Global Inflation", *Review of Economics and Statistics,* Forthcoming

[8] Chen N., J. M. Imbs and A. Scott (2004), "Competition, Globalization and the Decline of Inflation", CEPR Discussion Paper No. 4695.

[9] Christiano L., M. Eichenbaum and C. Evans (1999), "Monetary Shocks: What Have We Learned and To What End?", in J. B. Taylor and M. Woodford (Eds.), Handbook of Macroeconomics, Elsevier Science, North-Holland, New York, 1A, pp. 65-148.

[10] Cogley T. and T. Sargent (2006), "Drift and volatilities: monetary policies and outcomes in the post WWII US", *Review of Economic Dynamics*, *Vol. 8*, pp. 262-302.

[11] Corsetti G. and P. Pesenti (2005), "International Dimensions of Optimal Monetary Policy", *Journal of Monetary Economics 52(2)*, pp. 281-305.

[12] Fisher R. (2006), "Coping With Globalization's Impact on Monetary Policy", Speech at the 2006 ASSA Meeting, Boston, MA, January.

[13] Galati G. and Melick W. (2006), "The Evolving Inflation Process: An Overview", Bank of International Settlements Working Paper No. 196.

[14] Gali J. and T. Monacelli (2008), "Monetary Policy and Exchange Rate Volatility in a Small Open Economy", *Review of Economic Studies, Volume 72, Number 3,* pp. 707-734.

[15] Gamber E. N. and J. H. Hung (2001), "Has the Rise in Globalization Reduced U.S. Inflation in the 1990s?", *Economic Inquiry, Volume 39, Issue 1*, pp. 58-73.

[16] Guilloux S. and E. Kharroubi (2008), "Some Preliminary Evidence on the Globalization-Inflation Nexus", Federal Reserve Bank of Dallas, Globalization and Monetary Policy Institute, Working Paper No. 18.

[17] Ihrig J., S. B. Kamin, D. Lindner, J. Marquez (2007), "Some Simple Tests of the Globalization and Inflation Hypothesis", International Finance Discussion Paper, Board of Governors of the Federal Reserve System, N. 891

[18] Jacquier E., N. Polson and P. Rossi (2004), "Bayesian analysis of stochastic volatility models", *Journal of Business and Economic Statistics 12*, pp. 371–418.

[19] Kamin S., M. Marazzi and J. W. Schindler (2006), "The Impact of Chinese Exports on Global Import Prices", *Review of International Economics, Vol. 14, No. 2*, pp. 179-201.

[20] Kim C-J. and C. Nelson (1999), "State-Space Models with Regime Switching", MIT Press, Cambridge, Massachusetts.

[21] Kohn D. (2006), "The Effects of Globalization on Inflation and Their Implications for Monetary Policy", Speech at the Federal Reserve Bank of Boston's 51st Economic Conference, Chatham, MA, June.

[22] Leeper E., C. Sims and T. Zha (1996), "What Does Monetary Policy Do?", *Brookings Papers on Economic Activity 2*, pp. 1-78.

[23] Loretan M. (2005), "Indexes of the Foreign Exchange Value of the Dollar", Federal Reserve Bulletin, vol. 91 (Winter 2005), pp. 1-8.

[24] Milani F. (2009), "Global Slack and Domestic Inflation Rates: A Structural Investigation for the G-7 Countries", Working Paper, University of California - Irvine.

[25] Monacelli T. (2005), "Monetary Policy in a low Pass-Through Enviroment", *Journal of Money, credit and Banking 37(6)*, pp. 1047-1066.

[26] Mumtaz H. and P. Surico (2008), "Evolving international inflation dynamics:evidence from a time-varying dynamic factor model", Bank of England, Working Paper No. 341.

[27] Pain N., I. Koske and M. Sollie (2006), "Globalisation and Inflation in the OECD Economies", OECD Economic Department Working Paper No. 524.

[28] Primiceri G. (2005), "Time Varying Structural Vector Autoregressions and Monetary Policy", *Review of Economic Studies*, *Vol. 72, No. 3*, pp. 821-852

[29] Razin A. and A. Binyamini, (2007), "Flattened Inflation-Output Tradeoff and Enhanced Anti-Inflation Policy: Outcome of Globalization?" NBER Working Paper 13280.

[30] Rogoff K. (2003), "Globalization and Global Disinflation", *in Monetary Policy and Uncertainty: Adapting to a Changing Economy*, Federal Reserve Bank of Kansas City.

[31] Sbordone A., (2007), "Globalization and Inflation Dynamics: The Impact of Increased Competition," in J. Gali and M. J. Gertler ed., International Dimensions of Monetary Policy, University of Chicago Press.

[32] Tootell G. (1998), "Globalization and U.S. Inflation", Federal Reserve Bank of Boston, *New England Economic Review*, July/August, pp. 21-33.

[33] Wynne M. and E. Kersting (2007), "Openness and Infation", Federal Reserve of Dallas Staff Paper No. 2.

[34] Zaniboni N. (2008), "Globalization and Phillips Curve", mimeo, Princeton University.

Country	**Abbr.**	**Country**	**Abbr.**	**Country**	**Abbr.**
United States	*us*	*Australia*	*au*	*Italy*	*it*
United Kingdom	*uk*	*Japan*	*jp*	*Netherlands*	*nl*
Canada	*ca*	*South Korea*	*ko*	*Spain*	*es*
Germany	*ge*	*Austria*	*oe*	*Mexico*	*mx*
France	*fr*	*Ireland*	*ir*	*South Africa*	*sa*
Switzerland	*sw*	*Denmark*	*dk*	*New Zealand*	*nz*

Table 1: Abbreviations used as country codes in the Figures.

		us	*uk*	*ca*	*ge*	*fr*	*sw*	*au*	*jp*	*ko*	*oe*	*ir*	*dk*	*it*	*nl*	*es*	*mx*	*sa*	*nz*
β :	*pos.&signf.*	√	√	√	√				√	√				√					√
	decrease		√		√				√					√					
	GH 1		√		√				√					√					
δ :	*pos.&signf.*							√		√	√	√	√	√		√		√	√
	increase										√					√			
	GH 2										√					√			
γ :	*neg.&signf.*			√	√	√			√			√		√	√		√	√	√
	increase	√			√	√													√
	GH 3				√	√													√

Table 2: How the estimates of the coefficients of the domestic and foreign output gap (β and δ) and of the real exchange rate (γ) compare to the three GH hypothesis for the countries in our sample.

	$\boldsymbol{\pi}$	$\mathbf{y}^d$	$\mathbf{y}^f$	$\boldsymbol{\tau}$	$\mathbf{i}$
$\boldsymbol{\pi}$	x	x	0	x	0
$\mathbf{y}^d$	0	x	0	0	0
$\mathbf{y}^f$	0	0	x	0	0
$\boldsymbol{\tau}$	x	x	x	x	x
$\mathbf{i}$	x	x	x	x	x

Table 3: Identification Scheme Matrix for the no Choleski case. The zeros correspond to the restrictions imposed by the identification strategy, the $x's$ are the other free parameters.

Country	**Corr.**	**Country**	**Corr.**	**Country**	**Corr.**
United States	0.78	*Australia*	0.36	*Italy*	0.72
United Kingdom	0.52	*Japan*	0.43	*Netherlands*	0.68
Canada	0.76	*South Korea*	0.27	*Spain*	0.63
Germany	0.64	*Austria*	0.58	*Mexico*	0.05
France	0.70	*Ireland*	0.32	*South Africa*	0.23
Switzerland	0.62	*Denmark*	0.55	*New Zealand*	0.10

Table 4: Sample correlations of the domestic and foreign output gaps (y^d and y^f) by country.

	1980:85	**1986:90**	**1991:95**	**1996:00**	**2001:06**	**Δopen**
us	0.15	0.14	0.16	0.18	0.19	0.05
uk	0.43	0.40	0.39	0.42	0.38	−0.05
ca	0.47	0.46	0.50	0.66	0.63	0.16
ge	0.48	0.47	0.39	0.44	0.57	0.09
fr	0.39	0.34	0.34	0.41	0.45	0.05
sw	0.56	0.53	0.51	0.57	0.64	0.08
au	0.26	0.26	0.28	0.32	0.32	0.06
jp	0.24	0.17	0.15	0.17	0.22	−0.02
ko	0.61	0.56	0.48	0.57	0.62	0.02
oe	0.86	0.68	0.58	0.62	0.71	−0.15
ir	0.93	0.88	0.95	1.20	1.07	0.13
dk	0.57	0.49	0.48	0.53	0.58	0.01
it	0.48	0.38	0.34	0.37	0.40	−0.08
nl	0.97	0.84	0.77	0.85	1.10	0.13
es	0.29	0.27	0.29	0.38	0.40	0.11
mx	0.17	0.21	0.32	0.56	0.56	0.39
sa	0.54	0.50	0.41	0.49	0.57	0.04
nz	0.55	0.46	0.48	0.48	0.48	−0.07
all	0.50	0.45	0.43	0.51	0.55	0.05

Table 5: Degree of openness in the eighteen countries measured by the ratio to GDP of imports plus exports. Averages by half of decade since 1980.

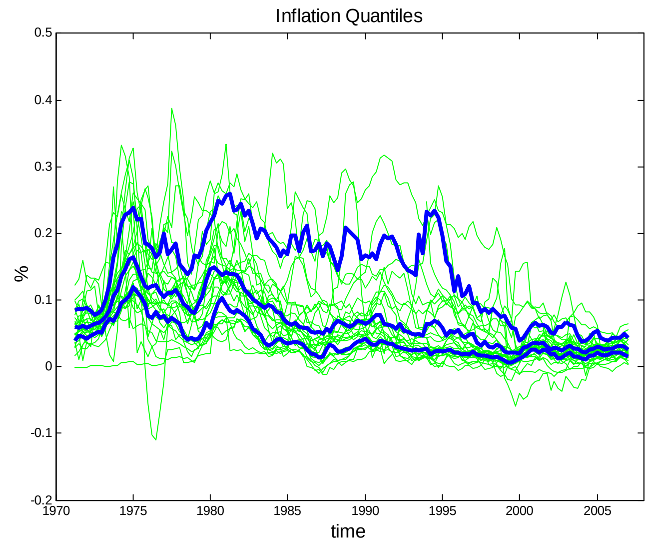

Figure 1: National inflations for a larger sample of countries. The thicker and darker lines represent the 5th, 50th and 95th percentiles of the distribution of the inflations. Period 1971 to 2006.

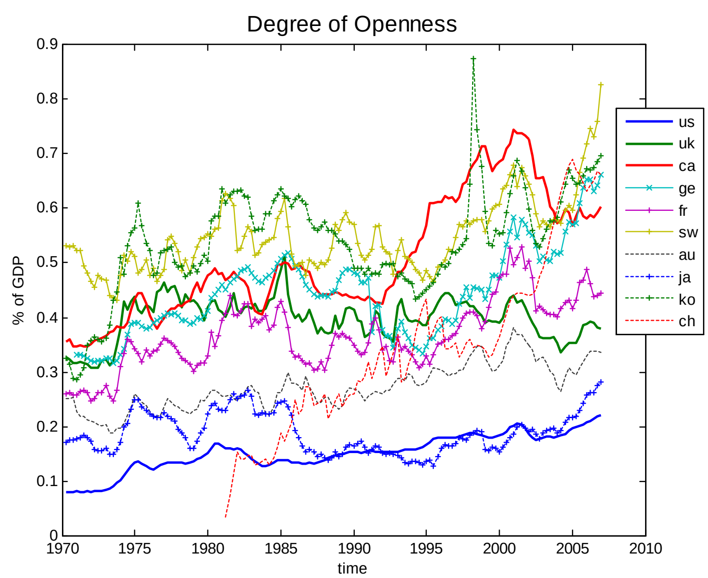

Figure 2: The Degree of Openness is measured as the sum of imports and exports as a ratio of GDP. The ten countries are: US, UK, Canada, Germany, France, Switzerland, Australia, Japan, South Korea, and China.

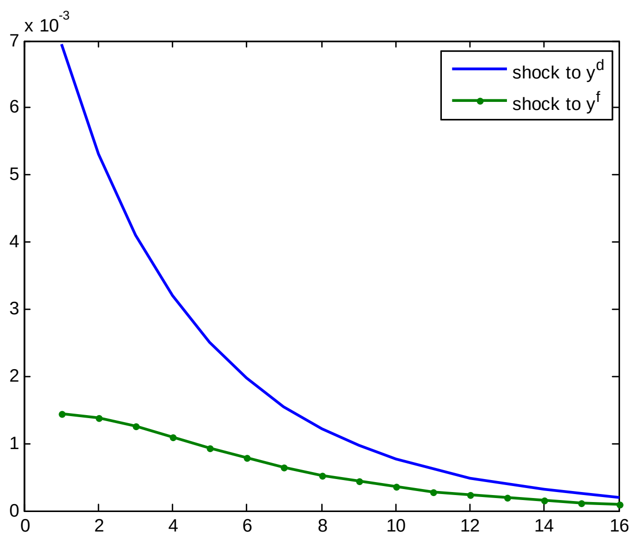

Figure 3: Response of the home country inflation to a 1% domestic and foreign output gap shock, in a standard New Keynesian open economy DSGE model (Zaniboni (08)).

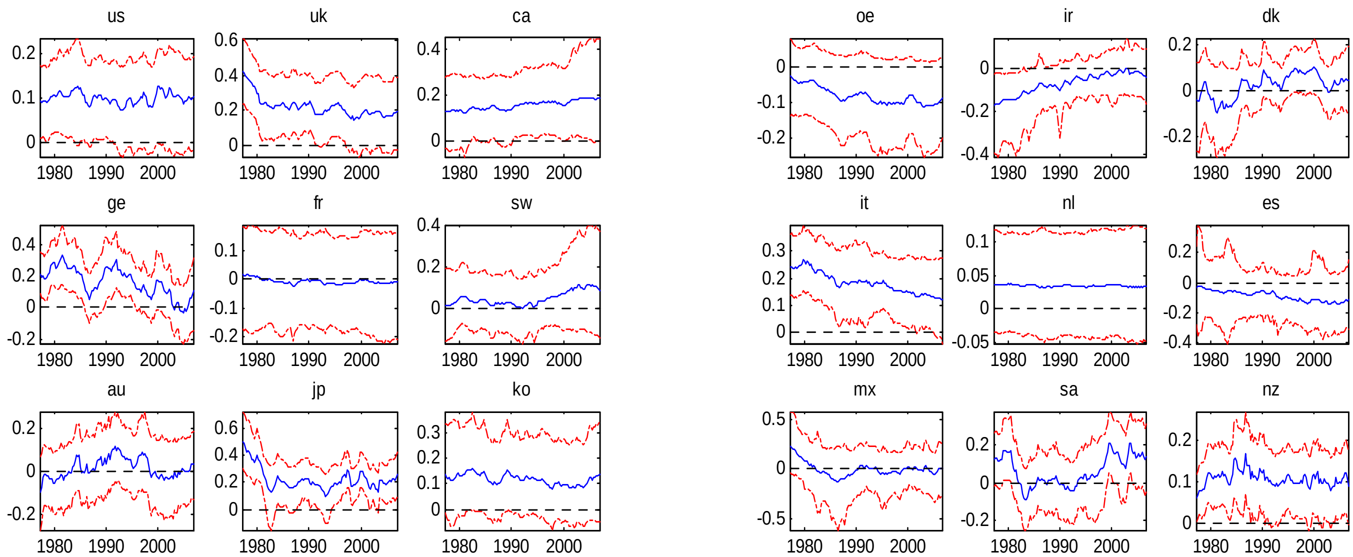

Figure 4: Time variation of the domestic gap coefficient β in the π-equation of the VAR. The bands show the $5th$ and $95th$ percentile of the posterior distribution of the coefficient.

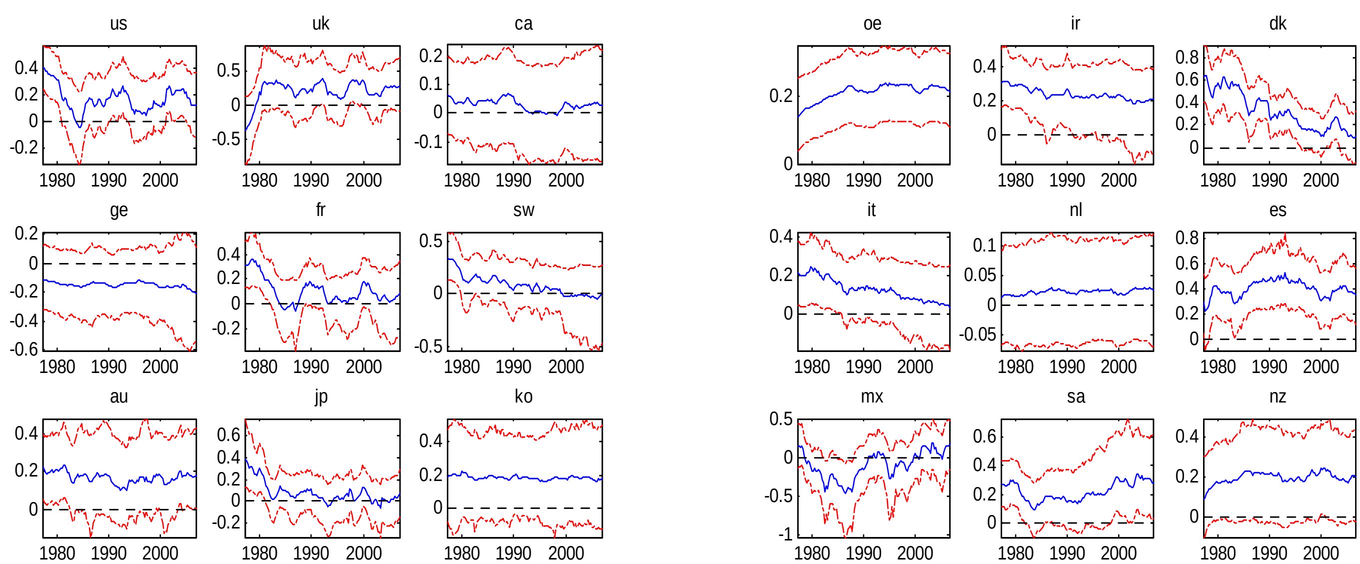

Figure 5: Time variation of the foreign gap coefficient δ in the π-equation of the VAR. The bands show the $5th$ and $95th$ percentile of the posterior distribution of the coefficient.

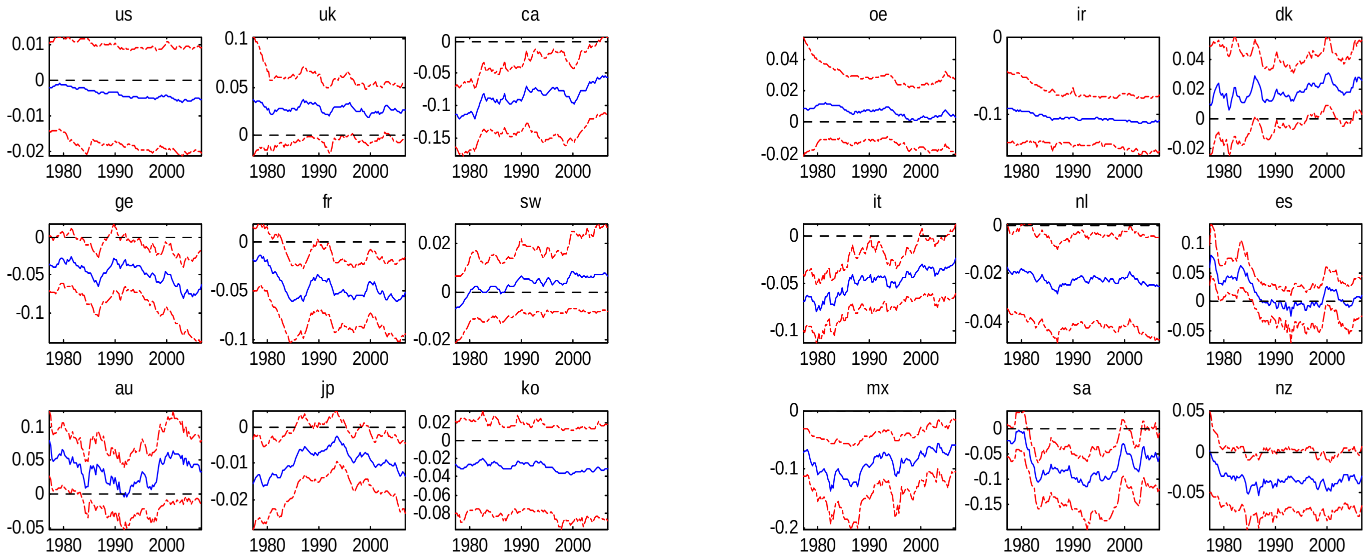

Figure 6: Time variation of the real exchange rate coefficient γ in the π-equation of the VAR. The bands show the $5th$ and $95th$ percentile of the posterior distribution of the coefficient.

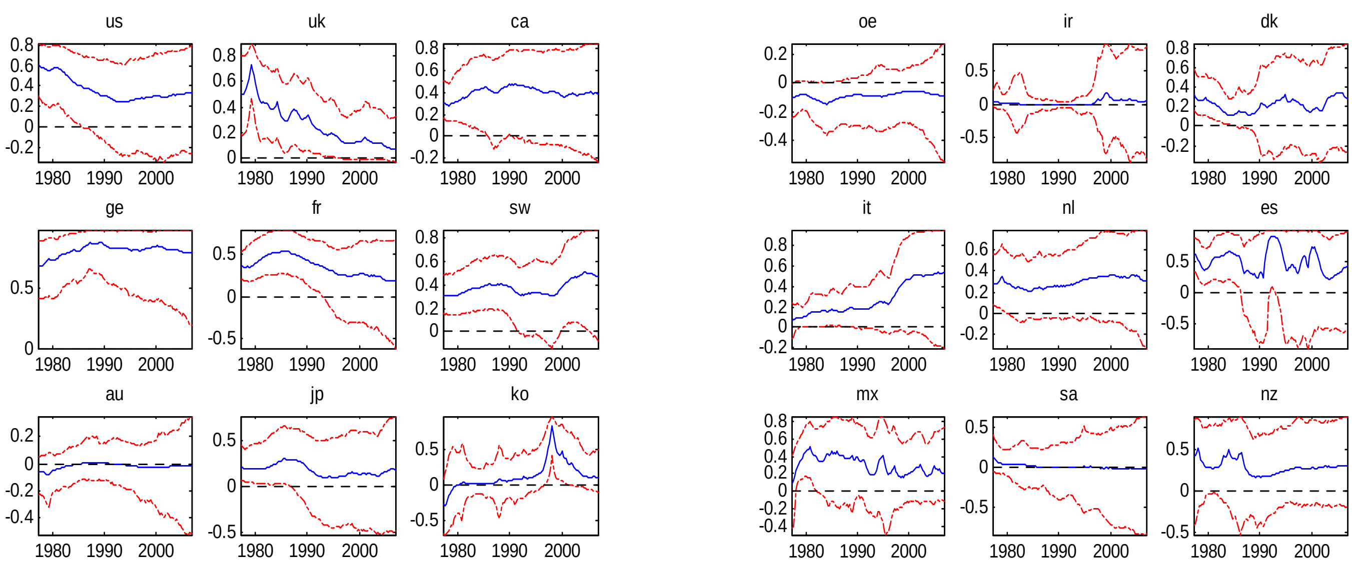

Figure 7: Time variation of the correlation of the reduced form residual of the y^d and y^f equations. The bands are the 5th and 95th percentiles of the posterior distribution.

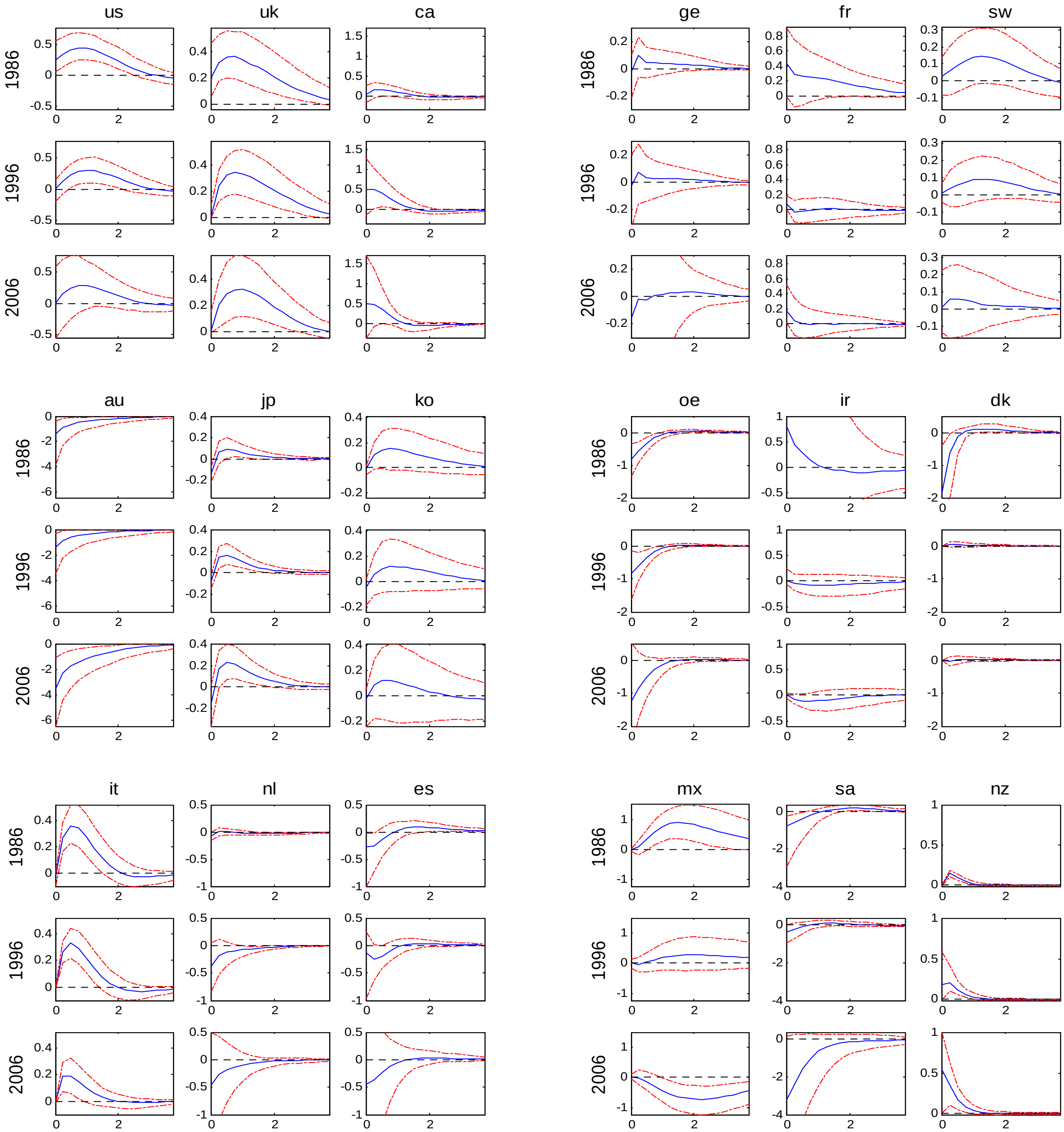

Figure 8: The response of inflation π to a unit shock to the domestic output gap y^d. First quarter of 1986 and 1996 and last of 2006. Identification strategy (y^f y^d π τ i). Bands at 14th and 86th percentiles.

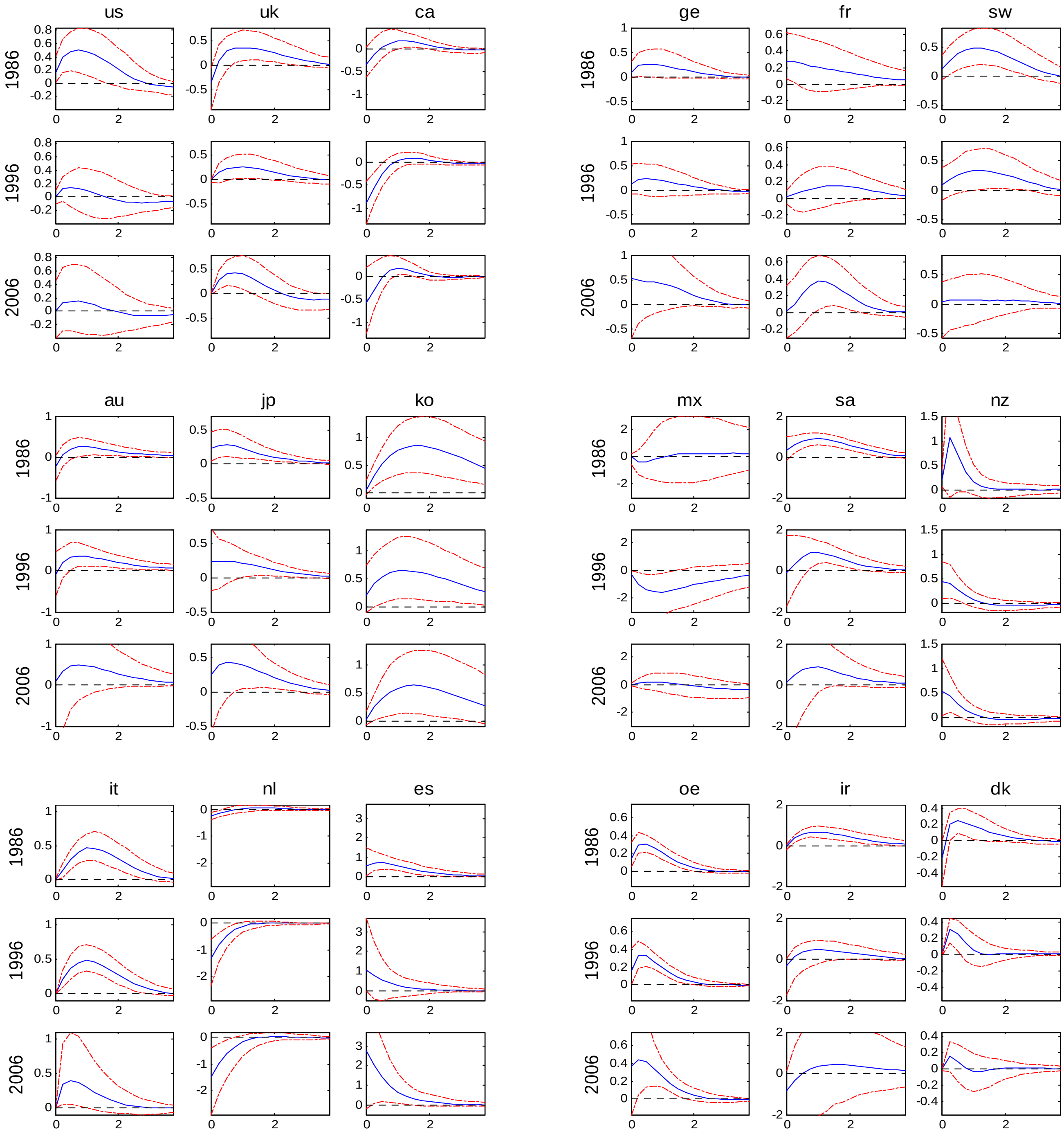

Figure 9: The response of inflation π to a unit shock to the foreign output gap y^f. First quarter of 1986 and 1996 and last of 2006. Identification strategy (y^f y^d π τ i). Bands at 14th and 86th percentiles.

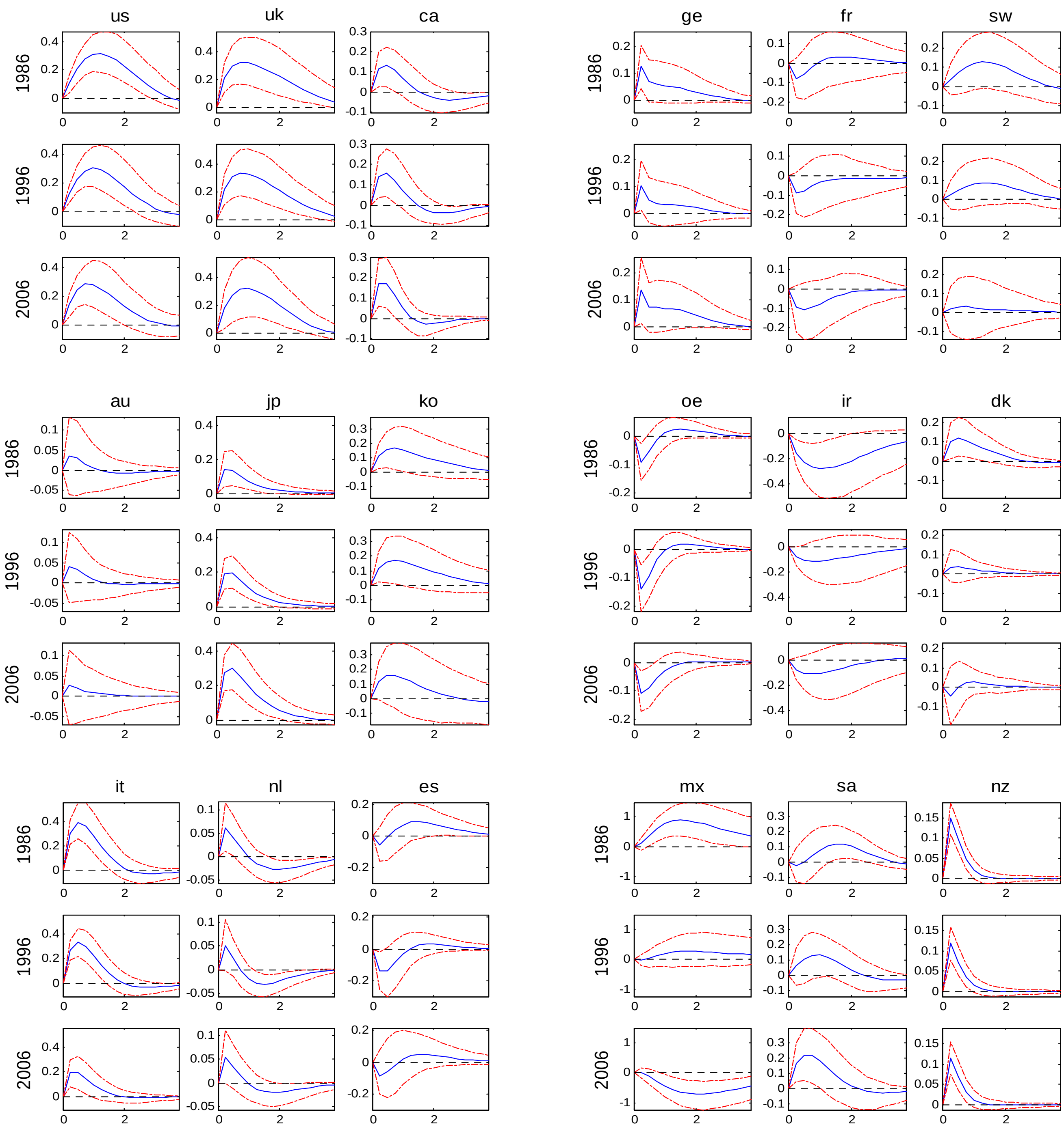

Figure 10: The response of inflation π to a unit shock to the domestic output gap y^d. First quarter of 1986 and 1996 and last of 2006. Identification strategy (π y^f y^d τ i). Bands at 14th and 86th percentiles.

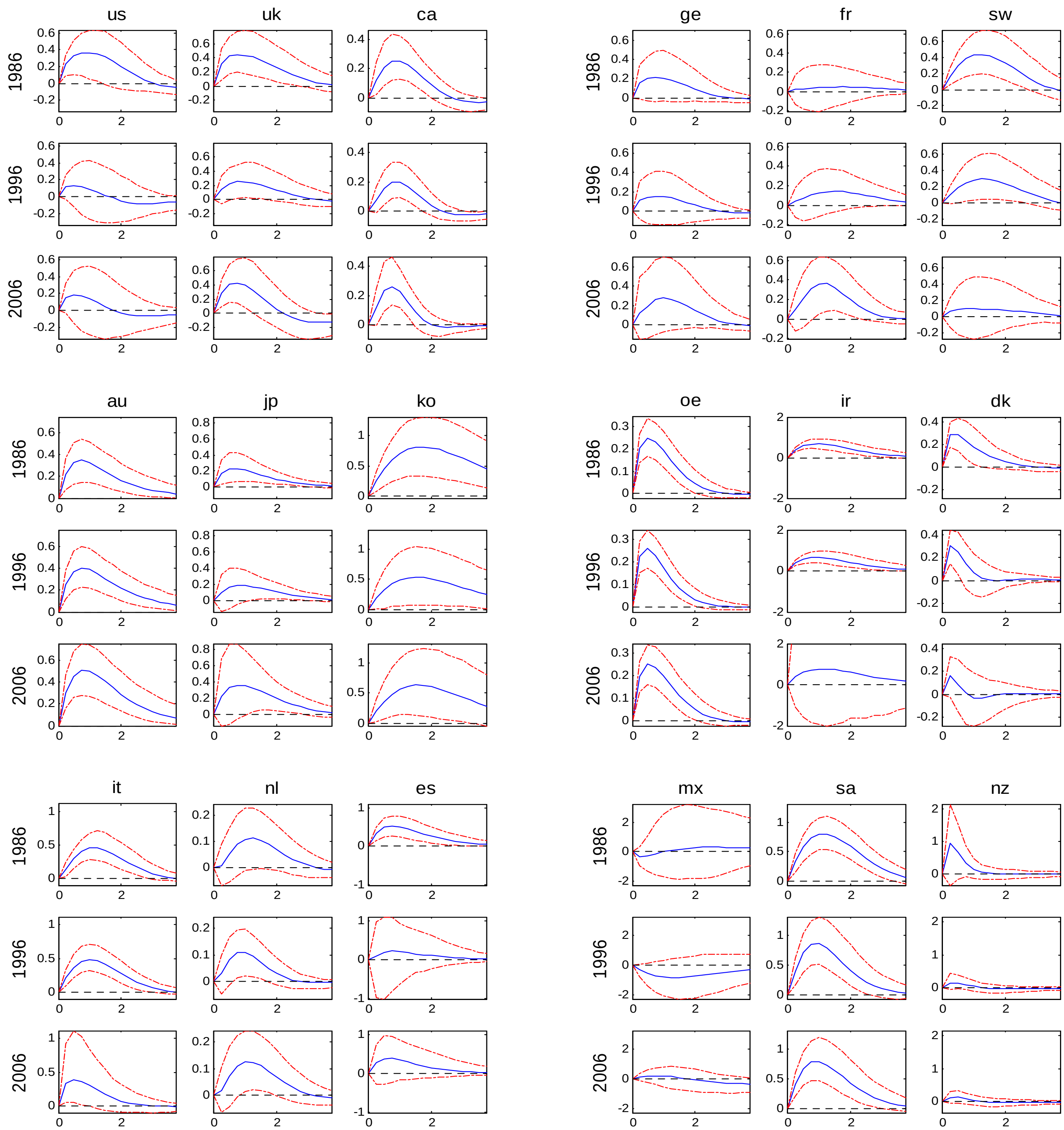

Figure 11: The response of inflation π to a unit shock to the foreign output gap y^f. Fourth quarter of 1986, 1996 and 2006. Identification strategy (π y^f y^d τ i). Bands at 14th and 86th percentiles.

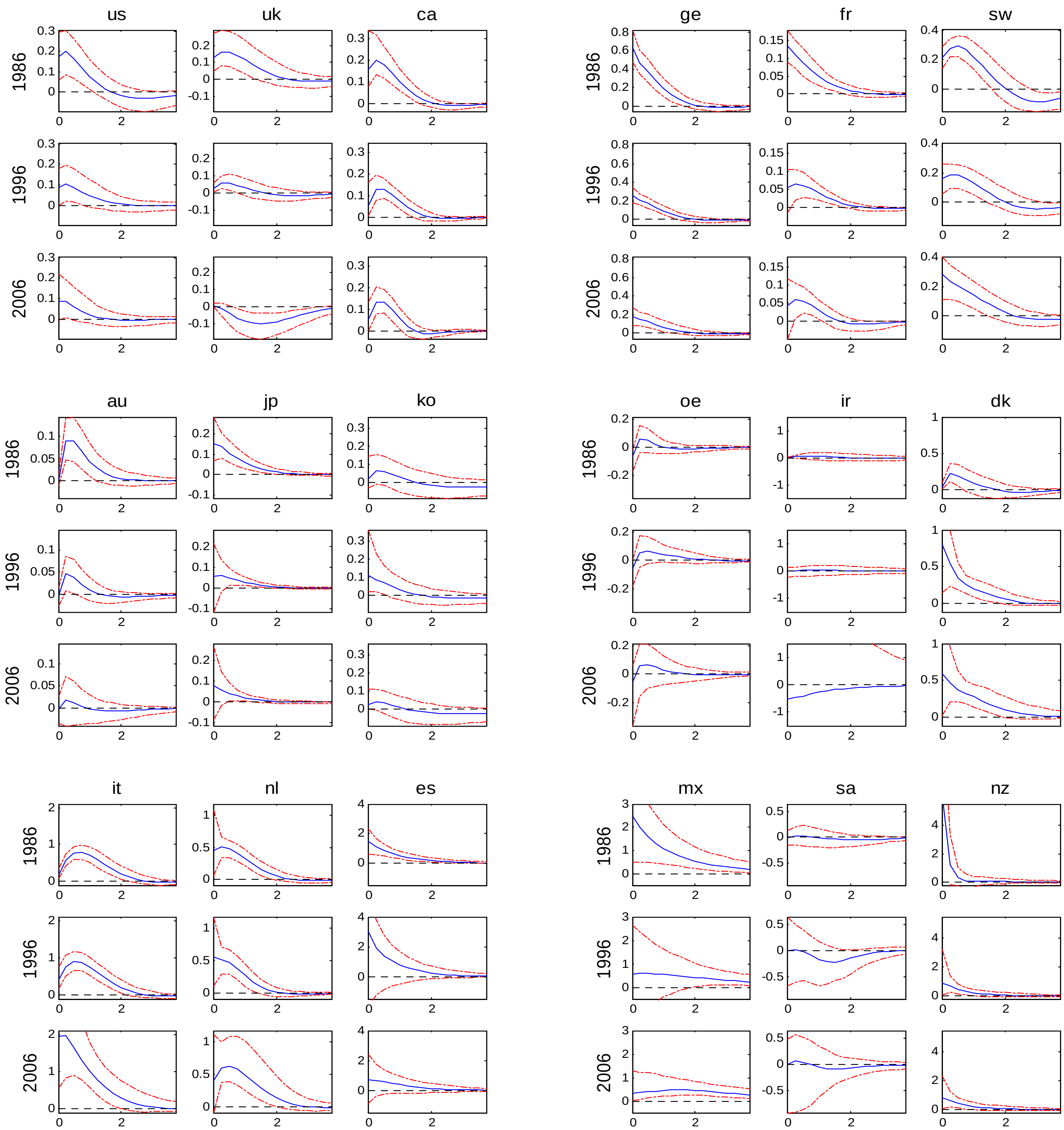

Figure 12: The response of domestic output gap y^d to a unit shock to the foreign output gap y^f. First quarter of 1986 and 1996 and last of 2006. Identification strategy (y^f y^d π τ i). Bands at 14th and 86th percentiles.

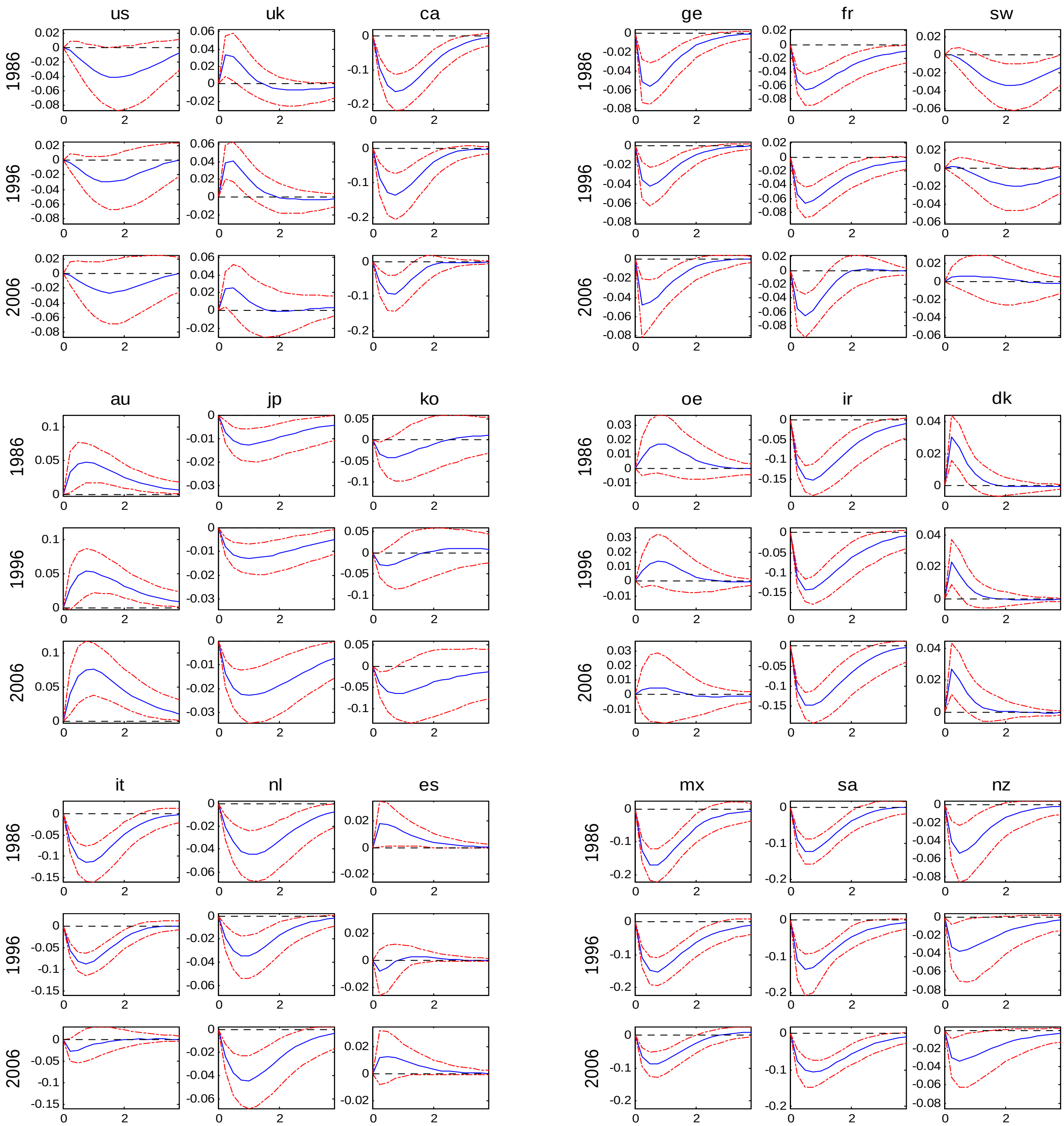

Figure 13: The response of domestic inflation π to a unit shock to the real exchange rate τ. First quarter of 1986 and 1996 and last of 2006. Identification strategy (y^f y^d π τ i). Bands at 14th and 86th percentiles.

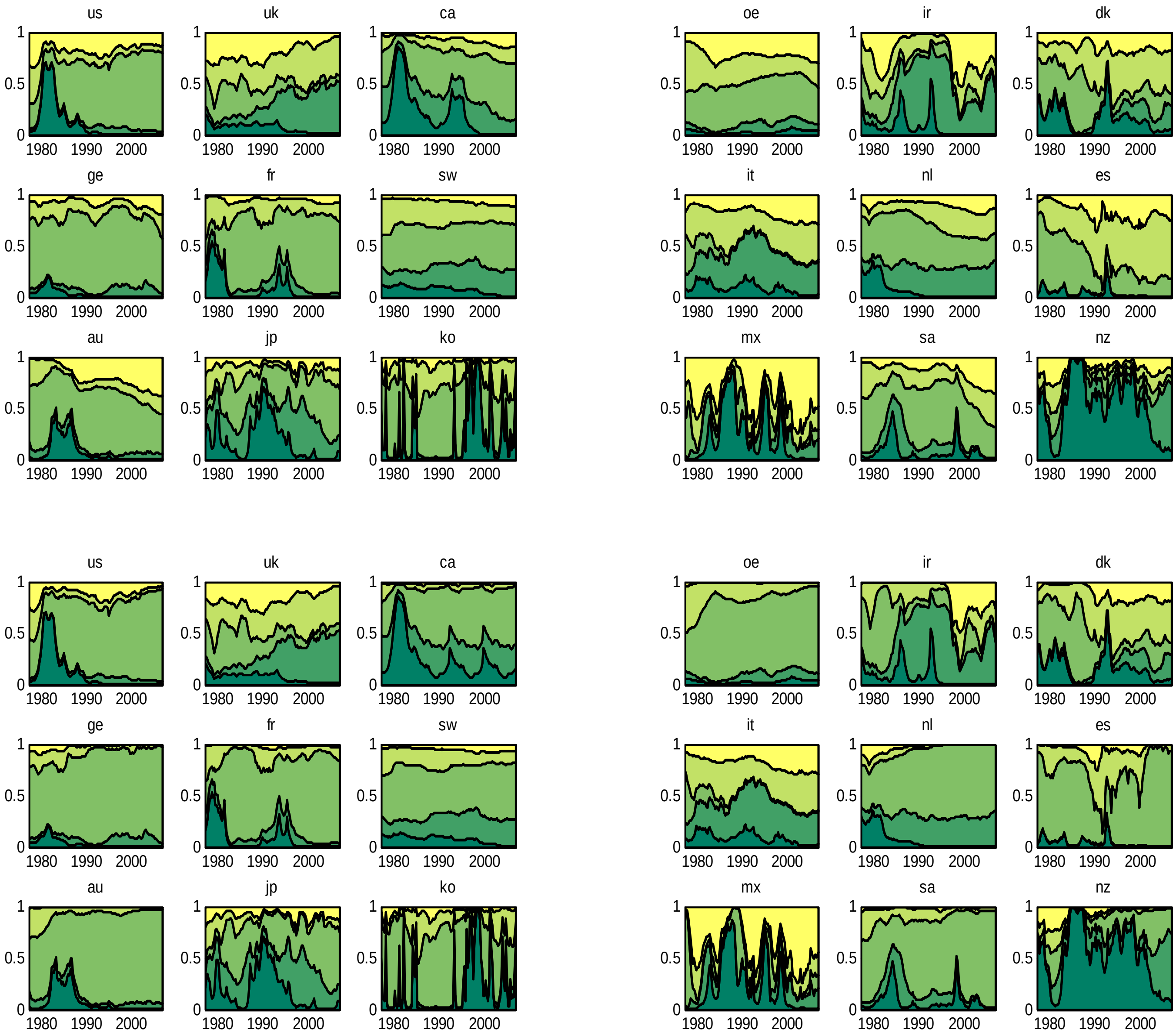

Figure 14: The time evolution of the decomposition of the variance of inflation. Identification scheme 1 in the top panel, scheme 2 in the bottom panel. From the top to the bottom (the lighter to the darker) the surfaces represent the respective contribution of the y^d, y^f, π, τ and i shocks.