STUDY CENTER GERZENSEE

Exchange Rate Pass-Through, Domestic Competition, and Inflation: Evidence from the 2005/08 Revaluation of the Renminbi

Raphael A. Auer

Working Paper 15.01

Exchange Rate Pass-Through, Domestic Competition, and Inflation: Evidence from the 2005/08 Revaluation of the Renminbi.*

Raphael A. Auer†

December 30, 2014

Abstract

Import competition from China is pervasive in the sense that for many good categories, the competitive environment that US firms face in these markets is strongly driven by the prices of Chinese imports, and so is their pricing decision. This paper quantifies the effect of the government-controlled appreciation of the Chinese renminbi vis-à-vis the USD from 2005 to 2008 on the prices charged by US domestic producers. In a panel spanning the period from 1994 to 2010 and including up to 519 manufacturing sectors, import price changes of Chinese goods pass into US producer prices at an average rate of 0.7, while import price changes that can be traced back to exchange rate movements of other trade partners only have mild effects on US prices. Further analysis points to the importance of trade integration, variable markups, and demand complementarities on the one side, and to the importance of imported intermediate goods on the other side as drivers of these patterns. Simulations incorporating these microeconomic findings reveal that a substantial revaluation of the renminbi would result in a pronounced increase of aggregate US producer price inflation.

Keywords: Price Complementarities, Exchange Rate Pass-Through, China, Inflation, Monetary Policy

JEL Classification Number: F11, F12, F14, F15, F16, F40, E31, E37, L16

*I thank Jessica Leutert for excellent research assistance and Luca Guerrieri, Rebecca Hellerstein, Maurice Obstfeld, and seminar participants at the Board of Governors of the Federal Reserve System, the European Central Bank, the Federal Reserve Bank of New York, the International Monetary Fund, and at the 2011 Conference on Exchange Rates and External Adjustment of the Bank of Canada and the European Central Bank for comments. The views expressed in this document are solely those of the author and do not necessarily reflect those of the Swiss National Bank

†Swiss National Bank and CEPR; raphael.auer@snb.ch.

1 Introduction

The topic of global imbalances in general and China's exchange rate policy against the US dollar in particular is one of the "most salient of controversies in international monetary economics" (Frankel (2010)). US policymakers have repeatedly demanded that China revalue its currency by 20% to 40% (see, for example, Geithner (2009)), demands that continue to be rebuked by Chinese officials. Given that the US trade deficit vis-à-vis China has not diminished with the recovery of the US economy from the financial crisis and there are no signs that it will do so in the foreseeable future (see Chinn et. al (2013)), this policy debate is likely to flare up again.

Rather surprisingly, the inflationary pressure that such an appreciation could cause has not been discussed in this policy debate. After all, the growth of Chinese import competition over the last two decades has been associated with enormous effects on the US economy. In terms of the effect on inflationary pressure, International Monetary Fund (2008), Bugamelli et al. (2010), Auer and Fischer (2010), and Auer et al. (2013) document the large impact of low-wage import competition on the prices that the producers in advanced economies charge domestically. For example, the baseline estimate of Auer and Fischer (2010) is that US PPI inflation would have been half a percentage point higher in the decade from 1997 to 2006 had such low-wage import competition been absent.[1]

If economic policies, such as for example a marked appreciation of the Renminbi (RMB), successfully reduce global imbalances,[2] the disinflationary effect of such inexpensive Chinese imports will, at least partly, be reversed. What would happen to US prices if firms producing one in six of the goods in the average US consumer's shopping basket (see Rynn (2005)), including the majority of clothing, toys, consumer electronics, and probably the shopping basket itself, suddenly faced 20% to 40% higher labor costs? Such an event would have a substantial direct impact on inflation because of the weight of Chinese goods in the US consumer price index (CPI). Further, such a dramatic shock might alter the equilibrium of the prices in many industries and lead to widespread inflationary dynamics also in the US domestic economy.

This paper quantifies the indirect inflationary effect of an appreciation of the RMB on the competitive environment in US producer markets and the prices that domestic producers charge. The main finding is that changes in Chinese import prices pass through into producer prices at much higher rate than do other import prices. In a panel of import and producer prices including up to 519 manufacturing sectors and spanning the period from 1994 to 2010, the rate at which import prices pass through into producer prices is

[1] In addition to this effect on specific sectoral prices, Chinese import competition also has generally held down wage inflation via its effect on certain parts of the US labor market. Autor et al. (2013) document that around a third of the decline in US manufacturing employment from 1990 to 2007 can be associated with increasing Chinese import competition. Further, such import competition also has effects on technology upgrading by US firms (see Bloom et al. (2011)) and thus on productivity and costs.

[2] It should be noted that - somewhat contrary to the believe of most policymakers - the empirical evidence is unclear as to whether moving to a flexible exchange rate regime actually speeds up external adjustment (see Chinn and Wei (2013)). Further, note that the bilateral imbalance of US-Chinese trade is much smaller when measured in terms of value added than when measured in terms of gross exports (see Johnson and Noguera (2012) and Koopman et al. (2014)).

estimated around 0.7 on average. This finding of high a pass-through rate supports the view of a "China price" effect, i.e. that because Chinese goods exert such strong competitive pressure on US prices, if that competitive pressure changes, there is a strong reaction of the prices that domestic firms charge.

The empirical analysis examines how the RMB appreciation is passed through into US import prices and, in turn, how these import prices affect US producer prices. The first part of this exercise is motivated by recent advances studying the microeconomic determinants of exchange rate pass-through into import and consumer prices .[3]

The first difference between this study and the literature on exchange rate pass-through is the focus on domestic prices. In the analysis below, the principal dependent variable of interest is US producer prices, which are measured as the "prices received by *domestic producers* for their output" (see Bureau of Labor Statistics (2010)), emphasis added).[4] China is the world's largest exporter, and the appreciation of the RMB will affect the equilibrium prices that US producers charge. In this paper, I aim to quantify the indirect effect of exchange rate changes on domestic price setting.[5]

The second difference between this study and the existing literature is that it focuses on exchange rate pass-through following a government-controlled appreciation instead of market-determined exchange rate fluctuations. It is important to acknowledge that the Chinese appreciation policy from 2005 to 2008 was not exogenous to other macroeconomic shocks that could have moved US prices. In particular, as argued by Frankel and Wei (2008), during this period, the RMB was essentially pegged to a currency basket with equal weights on the USD and the euro. Therefore, the analysis presented herein does not only include the periods during which the RMB appreciated. Rather, I also focus on the effects of the policy changes at the start or the end of the RMB appreciations. In particular, the analysis utilizes the periods during which the RMB was pegged to the USD to filter out the effects of other exchange rates on import and producer prices.

[3] One branch of research focuses on structural estimation of pricing-to-market in single industries (see for example Knetter (1993), Goldberg and Verboven (2001), or Nakamura and Zerom (2010); also see Auer et al. (2014)). More recent studies focus on reduced-form pass-through regressions in micro-datasets spanning many industries (see Gopinath and Rigobon (2008), Gopinath and Itskhoki (2010), Gopinath et al. (2010), Neiman (2010), and Auer and Schoenle (2014)). Further see, among others, Devereux and Engel (2002), Corsetti et al. (2004), Campa and Goldberg (2005), Atkeson and Burstein (2008), Auer and Chaney (2009), and Goldberg and Campa (2010).

[4] Bacchetta and Van Wincoop (2003), Burstein et al. (2003), Corsetti and Dedola (2005), and Goldberg and Campa (2010) argue that distribution cost intensity plays a major role in the rate of pass-through into consumer prices. Because the BLS considers retailing and wholesaling as services that are provided separately from the good itself (see Bureau of Labor Statistics (2010)), distribution costs account for a much smaller share of producer than of consumer prices.

[5] In this sense, the empirical exercise most closely related to this study is Chen et al. (2009), who analyze how long-run changes in import competition affect the intensity of competition and the prices of domestic firms. I do not analyze the long-run effect of increasing trade integration but the short-run dimension of how fluctuations in the exchange rate affect the domestic competitive environment via price complementarities. The notion that price complementarities matter also underlies the analysis of Gust et al. (2010), who analyze how increasing trade integration can lead to a lower degree of exchange rate pass-through, and of Atkeson and Burstein (2008), who examine whether a framework of imperfect competition and variable markups can reproduce main features of differences and international relative prices.

The analysis presented in this paper proceeds in five steps. In the first step, I discuss the Chinese exchange rate policy and show how the government's policy switches can be utilized to establish the effect of import price fluctuations on producer prices. The second step analyzes how the RMB exchange rate affected the prices of goods imported from China and the aggregate US import price indices (IPI). This step primarily documents that the RMB exchange rate alone had a substantial impact on the IPI from 2005 to 2008. The pass-through rate of the RMB into the IPI is on average estimated to be around 0.25. The *combined* pass-through rate of all of the other currencies is also estimated to be approximately 0.20.[6] Thus, the analysis finds that a 1% movement of the RMB has nearly the same effect on US import prices as a 1% movement of all other currencies *together*. This result is surprising given that in the sample of this study, China accounts for approximately 22% of all imports (30% towards the end of the sample).[7]

The third part of the analysis examines how RMB-induced fluctuations of US import prices influence the prices that US firms charge in two-stage least squares (2SLS) estimations. The analysis focuses on establishing the effect of the switch from a fixed exchange rate regime lasting from 1994 to 2005 to a regime of gradual appreciation from 2005 to 2008 (followed by another switch to a fixed regime until mid-2010). In a sample covering the period from 1994 to mid-2005 as a control period and then the time leading up to 2010 to evaluate how the pace of the RMB appreciation affects prices, I find that import prices affect producer prices of traded goods at an average rate of approximately 0.7. This result implies that a 10% RMB appreciation increases US producer prices by approximately 1.75% ($= 10\% * 0.25 * 0.7$). This result holds over a range of robustness tests and various time horizons.

To examine the mechanisms underlying the strong responses of domestic firms to foreign prices, the fourth step of the analysis investigates whether the pass-through rate is heterogeneous across sectors. I repeat the first-stage estimations and the 2SLS specifications dividing the sample by sector characteristics, such as the market share of Chinese exporters, the labor intensity of production, traded input intensity, and the shape of the demand for the sectors' goods. This analysis points to the importance of trade integration, variable markups, and demand complementarities on the one side, and to the importance of imported intermediate goods on the other side.

With regards trade integration, variable markups, and demand complementarities, while the degree of exchange rate pass-through is decreasing in the US sectoral market share of Chinese exporters, the rate at which changes in import prices affect producer prices is

[6] This finding is roughly in line with the results of the recent literature documenting that the rate of pass-through into the US IPI is currently rather low and takes values ranging from approximately 10% to 15% (compare to Marazzi et al. (2005) and Marazzi and Sheets (2007); also see Gust et al. (2010)).

[7] This paper examines the response of sectoral price indices published by the Bureau of Labor Statistics (BLS) rather than the response of individual prices in the micro data that underlie the BLS' price indices. This micro data have also been examined in the context of Sino-American trade by Kim et al. (2013). In relying on the official import price indices, the analysis implicitly accepts the BLS' procedure to deal with product discontinuations and introductions, which is subject to debate (see Nakamura and Steinsson (2012) – who focus on the long-run effects of item substitutions – and Gagnon et al. (2014) – who focus on sample exits).

increasing in the sectoral market share of Chinese exporters. These results are consistent with the theoretical predictions of frameworks featuring price complementarities and variable markups such as of Gust et al. (2010), Atkeson and Burstein (2008), or Auer and Schoenle (2014).

With regards to the importance of imported inputs, the reaction of producer prices to import price fluctuations is larger in sectors featuring more imported inputs, a prediction that is closely related to Auer and Mehrortra's (2014) analysis of exchange rate pass through to domestic prices in the presence of imported inputs, as well as to the broader issue examined in Auer et al. (2014) how the global value chain affects the international comovement of inflation.

The fifth and last step of the analysis uses these results to quantify the overall inflationary impulse of an RMB appreciation on the general inflation rate of US producer prices. I simulate the effect of an appreciation accounting for the fact that the pricing response is heterogeneous across sectors and across time, as well as for the autoregressive structure of producer and import prices. Once the price response at the sectoral level is estimated, I multiply each impact by the sector's weight in the overall PPI. Finally, summing over the weighted impulses at the sector level yields the magnitude of the total shock as a percentage of the overall US PPI.

These simulations reveal that a rapid RMB appreciation would lead to relative price shocks that are economically too large to ignore. For a scenario in which the RMB appreciates over 10 months at a rate of 2.5% per month, the total relative price shock expressed as a percentage of the US PPI inflation rate is predicted to be over 4 percentage points.

Overall, these findings support the view that, as the markets for domestic and imported manufactured goods are well integrated, the exchange rate can have a substantial impact on inflation even if the exchange rate affects import prices only to a small extent. The reason is that the exchange rate has a sizeable impact on the competitive environment of domestic producers and thus domestic prices.

2 Identifying the Effects of the Chinese Exchange Rate Policy

Perhaps as a reaction to prior criticisms (see Bosworth (2004) and Overholt (2003)) of a decade-old policy to keep the RMB fixed at a rate of 0.1208 USD/RMB, the Chinese authorities announced in July 2005 that they would switch to a new exchange regime in which the RMB is fixed to a basket of currencies.

Because neither the precise basket of currencies nor the underlying weights were ever published, there has been a considerable debate on which currency policy China actually followed during this episode (see Frankel and Wei (2007 and 2008) and Frankel (2009)). Although it is not precisely known why the Chinese government decided to revalue the RMB from time to time, the unambiguous result is that from 2005 to July 2008, the RMB appreciated a combined 21% against the dollar (from 0.1208 USD/RMB to 0.1462 USD/RMB; a change of 0.19 in terms of the natural logarithm). Figure 1 documents the evolution of the RMB/USD exchange rate since 1999 and the pronounced appreciation of the RMB that occurred during this period.

Analyzing the effects of this appreciation is complicated by the fact that the appreciation path of the RMB was endogenous to other economic developments. Figure 1 also documents the evolution of the EUR/USD exchange rate and suggests the following problem with this analysis. The RMB did not vary independently; rather, the rate of appreciation compared to the USD depended on the evolution of the euro. Frankel and Wei (2007 and 2008) carefully estimate the extent of this co-movement and find that the Chinese government followed a currency basket that gave at least as much weight to the euro as it did to the USD. This finding is problematic, as the EUR/USD exchange rate might on its own have a sizeable effect on US prices.

Never the less, the causal effect of the Chinese exchange rate policy can be quantified. Let $\Delta ppi_{j,t}$ denote the percentage change of US domestic prices in sector j and $\Delta ipi_{j,t}$ the percentage change of US import prices. Denoting other covariates in sector j and time t by $X_{j,t}$, the principle equation of interest is the relation between domestic and import prices, that is

$$\Delta PPI_{j,t} = \alpha_{ppi} + \beta \Delta IPI_{j,t} + \gamma'_{PPI} X_{j,t} + \epsilon_{ppi,t} \tag{1}$$

Import prices, in turn, are determined by the RMB exchange rate and the covariates[8]

$$\Delta IPI_{j,t} = \alpha_{ipi} + \delta_{RMB} \Delta e_{USD/RMB,t} + \gamma'_{IPI} X_{j,t} + \epsilon_{ipi,t}. \tag{2}$$

Of course, when evaluating the effect of the RMB on import prices, one must also consider the fact that the government-controlled path of the RMB reacts to other exchange rates. In particular, the Chinese exchange rate policy is such that before T_{Shift}, the exchange rate is flat against the dollar, while after that date, it co-moves with other exchange rates due to the fact that the Chinese implicitly were following a currency basket. Then, the movement of the USD-RMB exchange rate is given by

$$\Delta e_{USD/RMB,t} = \begin{cases} 0 \text{ if } t \leq T_{Shift} \\ \alpha_{yua} + \sum_{TP \neq Chi} \rho_{TP} \Delta e_{USD/TP,t} + \epsilon_{policy,t} \text{ if } t > T_{Shift} \end{cases} \tag{3}$$

where ρ is equal to the weight of the ROW exchange rate in the Chinese currency basket. The government-controlled appreciation process (3) after T_{Shift} poses a problem for the identification of the effects of the RMB appreciation, as the other exchange rates affect both import prices (2) and producer prices (1) directly on the one side, but on the other side the other exchange rates may also affect the path of the RMB appreciation itself.

If one were to restrict the sample to $t > T_{Shift}$, one could identify the coefficients only from $\epsilon_{policy,t}$, the deviations of the Chinese exchange rate policy from its currency basket. For example, if one assumes that the euro/ USD exchange rate ($\Delta e_{USD/Eur,t}$) is the only covariate in $X_{j,t}$, the import price regression (2) simplifies to

$$\Delta IPI_{j,t} = \alpha_{ipi} + \delta_{RMB} \alpha_{yua} + \left(\delta_{RMB} \rho'_{eur} + \gamma'_{ipi} \right) \Delta e_{USD/Eur,t} + \delta_{RMB} \epsilon_{policy,t} + \epsilon_{ipi,t},$$

[8] The set of covariates in equation (1) includes exchange rates other than the RMB.

where the estimation can only distinguish the direct effect of the euro on US import prices from the indirect effect via influencing the RMB exchange rate if the variance of $\epsilon_{policy,t}$ is of a large enough magnitude compared to the variance of $\Delta e_{USD/Eur,t}$. As document below, this is not the case, thus requiring a different approach.

However, inclusion of the pre-appreciation period in the sample makes it possible to filter out the direct effects of the other exchange rates. Consider an estimation that first filters out the effect of the RMB appreciation. The sample is split up in two periods (i.e., before and after the shift in the policy regime). Estimating the import price regression (2) using the sample $t \leq T_{Shift}$ when the RMB is fixed yields the coefficient estimates $\widehat{\gamma}_{ipi,t\leq T_{Shift}}$. Then, one can predict the effect of the other exchange rates after T_{Shift} by using the realizations of these exchange rates *after* T_{Shift} and the estimated coefficients $\gamma'_{IPI,t\leq T_{Shift}}$. That is, defining

$$\Delta\widehat{IPI}_{j,t>T_{Shift}} \equiv \widehat{\alpha}_{ipi,j,t\leq T_{Shift}} + \gamma'_{IPI,t\leq T_{Shift}} X_{j,t}$$

an estimation of the Chinese exchange rate policy on the actual changes of import prices net of what is to be expected based on the evolution of other exchange rates yields an unbiased estimate of δ_{RMB}, the impact of the RMB exchange rate on US import prices:

$$\Delta\widetilde{IPI}_{j,t} \equiv \Delta IPI_{j,t} - \Delta\widehat{IPI}_{j,t>T_{Shift}} = \delta_{RMB}\Delta e_{USD/RMB,t} + \epsilon_{ipi,t}. \tag{4}$$

Similarly, the relation between producer prices and import prices (1) can be filtered for the impact of the covariates.[9]

Overall, the above implies the following strategy to identify the effect of the Chinese exchange rate on US prices. I first identify the coefficients of the covariates based on the time period when the RMB was fixed to the USD and thereafter estimate the effect of the RMB fluctuations conditional on the effects of the other exchange rates being netted out from the import prices. The identification in this paper thus derives from the period during which the RMB was fixed to the USD and not from the appreciation period itself.[10]

[9] Of course, given that the estimated specifications only account for linear relations between these variables, the filtering approach adopted in (4) is misfit if the underlying economic relations are indeed non-linear.

[10] A related strategy would be to include all variables and estimate (3) and (2) in the entire sample spanning the time period from 1994 to 2010. Given that the pre-2005 variation identifies the effects of all of the covariates, the post-2005 variation can be attributed to either the effect of the covariates or to the RMB appreciation. If the true underlying coefficients were constant in the two parts of the sample, this approach would be identical to the previously discussed filtering strategy. However, in practice, this second approach needs to be modified by the inclusion of one additional dummy because during the pre-2005 period, the average rate of global inflation was much lower than it was from 2005 to 2008, which was a period characterized by rising prices around the globe. Thus, the estimation in the entire sample length includes one sub-period of 0 RMB appreciation and low inflation and another sub-period of high inflation and positive RMB appreciation. Consequently, the coefficient of the RMB appreciation is driven mostly by the differences between these two periods, rather than the variance in the path of the RMB within the appreciation period. I thank Rob Vigusen for pointing out this estimation problem.

3 Exchange Rate Pass-Through into Import Prices

This section documents how movements of the RMB affect the prices of Chinese goods and the overall US import price index. It estimates the response of US import and producer prices in a monthly panel dataset spanning the years from January 1994 to December 2010 and in a baseline specification including 418 sectors. The data assembly is described in the appendix.

As China accounted for around 30% of all US imports in 2011, price changes of Chinese goods have a sizeable direct mechanical impact on the overall US import index. Thus, the RMB directly affects the US IPI if the prices of Chinese goods react to the RMB. Figure 2 relates the evolution of the RMB-USD exchange rate (right axis in RMB/USD) to the US import price index of all goods originating from China (left axis). Figure 3 documents the relationship between the RMB and the prices of Chinese imports more closely by relating the 6−months cumulative change in the RMB exchange rate (a positive value implies an RMB appreciation) to the 6−months cumulative change in the US import price index of goods originating from China. There is a strong positive association between the value of the RMB and the prices of Chinese goods in the US, with the slope being estimated significantly positive at 0.55. Kim et al. (2013) examine the pass-through rate of the RMB into individual goods using a micro data set of import prices that the BLS uses to calculate the Chinese import price index displayed in Figures 2 and 3 (see Gopinath and Rigobon (2008) for a description of this data set). Kim et al.'s (2013) main conclusion is that at horizons of 12 months or longer, the pass through of the RMB is high and is estimated at up to 0.8.

How does the RMB affect the general US import price level? In addition to the direct effect via the prices of Chinese goods, the RMB also indirectly affects the US IPI, as the prices of imported goods from other destinations also react to the prices of Chinese imports. Bergin and Feenstra (2009) and Pennings (2013) analyze this rate of "cross-currency pass-through" (that is, the rate at which for example Japanese import prices react to fluctuations in the RMB) and uncover a strong co-movement of prices to exchange rates other than the one that the product is from. As a result, an RMB appreciation leads to an overall pass-through rate of the RMB into the US import price index that can be substantially larger than the accounting component alone.[11]

Table 1 documents the effect of changes in the RMB on sectoral US import price indices and thereafter introduces the empirical approach outlined in Section 2 above. All columns present the results of fixed effects panel estimations evaluating 3-months cumulative changes in the US IPIs at the 5−digit level of disaggregation. Column (1) presents the baseline correlation between import prices and the RMB. β_{RMB} denotes the rate of pass-through, i.e. the elasticity at which the sectoral IPI reacts to changes in the USD/RMB rate. The estimated specification is

$$\Delta IPI_{t,j} = \alpha_j + \beta_{RMB} \Delta e_{USD/RMB_t} + \gamma_j' X_t + \epsilon_{j,t}.$$

[11] Itskhoki and Gopinath (2011) and Auer and Schoenle (2014) directly document that firms react to their competitors' prices.

In (1), only monthly seasonality dummies are added as a control. The specification is estimated in the sample from June 2005 onwards. The coefficient of the RMB is estimated at 0.563, implying that a 1% increase in the USD/RMB exchange rate leads to an increase in the US IPI of 0.563%.

From Column (2) onwards, further controls are added. In the estimation of Column (2), the specification includes the Rest-of-the-World (ROW) exchange rate, the PPI inflation rate in all of trade partners (trade-weighted), and the Goldman Sachs Commodity Index. The ROW exchange rate is defined as the weighted change of the USD vis-à-vis all trade partners other than China and using US import weights. For all of the variables, the cumulative changes at the 3-months horizon are constructed, and the following fixed effects panel specification is estimated.

$$\Delta IPI_{t,j} = \alpha_j + \beta_{RMB} \Delta e_{USD/RMB_t} + \beta_{ROW} \Delta e_{USD/ROW_t} + \gamma' X_t + \epsilon_{j,t} \qquad (5)$$

Controlling for commodity prices and the exchange rate in other countries dramatically changes the coefficient of the RMB. For example, it decreases from 0.56 to 0.245 (see Columns (1) and (2), respectively) when the ROW exchange rate, producer prices, and commodity prices are included as controls.

The coefficient of 0.245 is large given that in the sample included in Column (1), China on average accounts for 22% of all imports. Consequently, only a substantial "cross-currency" pass-through rate – other import prices reacting to changing Chinese prices – could explain the sizeable effect of the RMB on the US IPI. For example, even if the PT rate of the RMB on Chinese goods is equal to 0.8 (the long run pass-through rate estimated in Kim et al. (2013)), the accounting component explains only 0.176 ($= 22\% * 0.8$) of the total effect of 0.245 of the RMB on the IPI, with the remainder being due to the reaction of prices of other importers to the Chinese exchange rate.[12]

There are two choices to make when implementing the empirical strategy outlined in Section 2 above. A first choice concerns the set of other exchange rates on which to condition on, and the second one concerns whether and how to incorporate nominal exchange rates and PPI dynamics in China.

Including only one aggregate ROW exchange rate might hide a substantial degree of heterogeneity in pass-through responses across different trade partners. To address this potential heterogeneity, the estimation in (3) thus adds the trade-weighted average change of the USD versus non-OECD members (excluding China) to the estimation in Column (2). Given that the ROW exchange rate is still included in this specification, the insignificant coefficient of 0.056 for the non-OECD exchange rate implies that there is no difference in the pass-through rate between OECD and non-OECD members.

Instead of splitting the trade partners into groups, the estimation in Column (4) directly adds the exchange rates of the five biggest trade partners other than China (by imports in

[12] For small price changes, it holds that the change in the total IPI is equal to the weighted sum of importer-specific IPIs, with weights being equal to the import share of each exporter. The results of Column (2) thus imply that the average rate of cross-currency pass through for the RMB – defined as the elasticity of non-Chinese import prices to the USD/RMB exchange rate – is equal to 0.088, thus satisfying $0.8 * 0.22 + 0.088 * 0.78 \approx 0.245$.

2010: Canada, Euro Area, Mexico, Japan, and Korea), as well as the main sources of US oil imports (in addition to Canada and Mexico, Saudi Arabia and Venezuela).

These results uncover that while the response of US import prices to exchange rates is heterogeneous across the various trade partners, the main coefficient of interest, the one of the change in the US-Chinese exchange rate, is not affected much by controlling for individual exchange rates rather than only for the trade-weighted average ROW exchange rate.

Examining the response of US import prices to changes in the nominal exchange rate does not take into account that production costs in China change over time. Column (5) thus controls for the 3-months cumulative change in the exchange rate plus the corresponding change in Chinese producer prices. Addition of producer price dynamics in China has little impact on the estimated coefficient, but does substantially improve the statistical fit of the model (compare both coefficients and standard errors in Columns (2) and (5)). However, despite the gained significance this estimation is subject to the caveat that the National Bureau of Statistics China, the Chinese statistical office, only publishes a series of annual producer price inflation and only an imperfect quarterly measure can be constructed from this measure (see appendix for a discussion).[13]

Given the small impact on the coefficients and this data limitation, the remainder of the analysis proceeds using only the nominal USD/RMB exchange rate as depending variable.

Based on the choice to condition on the ROW exchange rate and to use the nominal RMB/USD exchange rate, I next follow the methodology described in Section 2 and use the information from the decade during which the RMB was fixed to the USD to filter out the impact of the ROW exchange rate on sectoral import prices. In Column (6), the sample includes the time period from January 1995 to June 2005. The specification includes changes in the US IPI as dependent variable and changes in the ROW exchange rate as independent variable. In contrast to the specifications in the samples including the time period after June 2005 (the post-2005 sample from here on), the effect of the ROW exchange rate on the US IPI is sizeable: it is estimated at 0.147.

The last specification of Table 1, presented in Column (7), presents the effect of the RMB on the US IPI after the effect of the ROW exchange rate is netted out using the coefficient from Column (6). The methodology is as discussed in Section 2. The pre-2005 coefficient of 0.147 from Column (6), together with the realizations of the ROW exchange rate after 2005 is used to subtract the ROW exchange rate's effect in the post-2005 period from the actual IPI realizations in the post-2005 sample. In Column (7), The coefficient of the USD/RMB exchange rate on the filtered IPI is estimated at 0.292.

The coefficients in the estimation including the ROW exchange rate in Column (2) and the coefficients in the estimation with the filtered import price index in Column (7) compare as follows. In Column (7), the dependent variable is $\Delta \widetilde{IPI}_{j,t}$, which is constructed as in (1)

[13] Chinese and US producer prices might be correlated due to common sectoral shocks. Given that the ultimate focus of this paper is to examine the response of US producer prices to the USD/RMB exchange rate, including Chinese producer prices in the estimations could be spurious. Note, however, that Holz and Mehrotra (2013) examine the spillover of growth in labor costs in China into Chinese prices, finding that such pass-through is limited.

and equal to $IPI_{j,t} - 0.147 * \Delta e_{USD/RMB_t}$. The estimation in Column (7) is thus identical to the estimation in Column (2) with the coefficient for $\Delta e_{USD/RMB_t}$ restricted to equal 0.147. Because the latter is estimated at 0.072 in Column (2), and because the change in the USD/RMB and the change in the ROW exchange rate are negatively correlated, the coefficient of interest, the one of USD/RMB, is estimated at 0.292 in Column (7), which is larger than the coefficient estimate of 0.245 in Column (2).

In the specification of Column (7), the effect of the RMB on the IPI after filtering out the effects of the other controls is estimated to be 0.292. Again using the PT rate of 0.8 for individual Chinese goods from Kim et al. (2013) and the average Chinese import share of 22%, these results imply that the direct accounting component of Chinese imports explains 0.176 ($\approx 0.8 * 0.22$) of the total coefficient of 0.292, with the indirect response of non-Chinese import prices to changing Chinese import prices explaining the remainder of the total response of the IPI to the RMB exchange rate.

Figure 4 documents the cumulative pass-through rate estimated at various horizons for the changes in the RMB (black solid line, surrounded by two dashed lines representing the 95% confidence interval (CI)). The pass-through coefficients displayed in this figure are computed in the same manner as those computed for specifications of Columns (6) and (7), with the effect of the ROW exchange rate being netted out from a specifications of the type presented in Column (6). Each point in Figure 4 presents the rate of conditional pass-through resulting from a fixed effects panel regression of the "cumulative import price change over the last n months, net of ROW exchange rate effect" as the dependent variable on the "cumulative RMB exchange rate change over the last n months" as independent variable, with n varying from one to 24. The response of the IPI to the RMB follows a hump-shaped pattern, with the coefficient increasing up to 0.47 at the $7-$months horizon and decreasing to 0.16 after 20 months.

4 Pass-Through Into Producer Prices

Table 2 examines the response of US producer prices to changes in import prices that are driven by movement in the USD/RMB exchange rate. Specifications (1) to (6) serve to introduce the empirical implementation of the strategy outlined in Section 2.

The OLS relation between import and producer prices is substantially stronger after 2005 than in the time from 1995 to 2005. Columns (1) and (2) present the OLS relation between the import and producer prices. In Column (1), the panel includes 411 $6-$digit NAICS sectors from January 1995 to June 2005. The coefficient of the IPI is estimated to be 0.111 (that is, a 10% increase in import prices implies only a 1.1% increase in producer prices) and is significant. In contrast, the same estimation in the sample of Column (2), which includes 418 $6-$digit NAICS sectors and the time period starting after June 2005, results in a coefficient of 0.349 (that is, the coefficient is well over three times as large as in Column (1)).[14]

[14] Since the analysis in Table 2 is at the 6-digit NAICS level of disaggregation (yielding up to 417 sectoral PP indices), while information on import prices is available only up to the 5-digit NAICS level of disaggregation, all specifications in Table 2 report standard errors clustered at the 5-digit NAICS level

Columns (3) and (4) demonstrate that this increasing correlation between the import and producer prices is also visible when conditioning on the ROW exchange rate, PPI inflation abroad, and global commodity prices. The estimation in Column (4) indicates that an appreciation of the ROW exchange rate is even associated with lower US producer prices once changes in the IPI are included in the OLS regression. This coefficient has to be interpreted with care, however, as the ROW exchange rate also moves the IPI itself. The next specifications address this relation in the data.

Column (5) documents that the ROW exchange rate has no effect on producer prices other than via moving import prices. In Column (5), the ROW exchange rate is insignificant in the post-2005 sample once its impact on import prices is netted out from the IPI. The estimation in Column (5) includes the filtered IPI rather than the actual IPI as dependent variable. The filtered IPI is constructed as described in Section 2 and filters out the effects of the ROW exchange rate on the IPI by using the relation between those two variables in the pre-2005 sample, which is estimated in Table 1 (see Column (6)). Using the coefficients from Column (6) in Table 1, the relation is predicted for the post-2005 sample, and this predicted effect is then netted out from the post-2005 IP-inflation. The variable "filtered IPI" thus measures the change in the IPI had the ROW exchange rate not moved during the post-2005 period.

The results of Table 1 indicate that the RMB is an important driver of US import prices, while the results of Column (5) indicate that the ROW exchange rate has no effects on producer prices once its impact on import prices is accounted for. Column (6) of Table 2 combines these two insights into a two-stage least square estimation (2SLS) relating changes in the RMB to changes in the US IPI and, in turn, RMB-induced IPI movements to sectoral PPI developments.

In the 2SLS estimation of Column (6), the sample includes the post-2005 period and the instrumented change in the filtered sectoral IPI is the only independent variable. The latter variable is the first-stage projection with the change in the filtered IPI as dependent and the change in the RMB as independent variable. The estimated equation is

$$\Delta PPI_{j,t,j} = \alpha_j^{PPI} + \beta^{PPI} \Delta \widetilde{IPI}_{j,t,j} + \gamma^{PPI} PPI_{World,t} + \delta^{PPI} GSCI_{World,t} + \eta_j^{PPI\prime} \Pi_t + \epsilon_{j,t}^{PPI}$$

where $\Delta \widetilde{IPI}_{j,t,j}$ is the first-stage projection from the regression on $\Delta IPI_{j,t,j}$

$$\Delta IPI_{j,t,j} = \alpha_j + \beta \Delta e_{USD/RMB_{t-n}} + \eta_j' \Pi_t + \epsilon_{j,t}$$

that is estimated in the pre-2005 sample and predicted to the post-2005 period.

The results from the specification of Column (6) reveal that the RMB-induced movements of import prices have a strong overall impact on the prices charged by US firms. The coefficient is estimated to be 0.8, which, given the corresponding first-stage coefficient of 0.292 (see Column (7) in Table 1), implies that a 10% appreciation in the RMB increases import prices by 2.92% and producer prices by 2.336% ($= 0.8 * 2.92\%$).

For the 2SLS presented in Column (6), the first-stage estimation is identical to the estimation presented in Column (7) of Table 1 and is thus not reported. However, the bottom

(depending on the specification, up to 118 clusters).

of Table 2 reports additional statistics of the 2SLS estimation. To test for weak identification, the bottom of Table 1 reports the p-value associated with Anderson's canonical correlation LR statistic and the lowest critical value for the maximum IV bias/size that can be rejected.[15]

A limitation of the estimation presented in Column (6) is that it is not possible to directly control for the effect of the ROW exchange rate on the PPI, as the inclusion of this variable in the second-stage estimation necessitates the inclusion of this variable into the first-stage estimation. Therefore, attempting to control for the effect of the ROW exchange rate on the PPI invalidates the identification strategy proposed in Section 2 above. Column (7) thus adds this variable to the specification of Column (6). The coefficient of the ROW exchange rate is estimated at -0.099 and is statistically highly significant.

Column (8) thus also filters out the effects of the ROW exchange rate on the PPI index by using the pre-2005 sample, which is performed in the left sub-column (8A). In this specification, the relation between the ROW exchange rate and US PP-inflation is estimated. The resulting relation is then predicted for the post-2005 sample, and this projection is then subtracted from post-2005 PP-inflation. The specification in sub-column (8B) examines the effects of the RMB-induced movements of import prices on the filtered producer price changes in the 2SLS specification and uncovers a coefficient of 0.712, which is not too different from the coefficient found in Column (6) of Table 2.

In much the same manner that exchange rates affect import prices only slowly over time, also import prices affect producer prices only with a lag. Figure 5 displays the time profile of the rate at which the RMB-induced IPI movements affect the PPI. Each of the 24 data points in this figure corresponds to an estimation along the lines of Columns 8a and 8b in Table 2, with the time horizon ranging from one to 24 months. That is, for each of these data points, a 2SLS estimation relating the filtered PPI change to the filtered and instrumented IPI change is estimated in the post-2005 period. Furthermore, the upper and lower boundaries of the 95% confidence interval for each coefficient are displayed.

At most horizons (except the 1-month horizon and the horizons over 20 months), the coefficient is stable throughout time and the 2SLS coefficient is equal to roughly 0.7. There is no large difference whether one also filters out the effect of the ROW exchange rate on the PPI (black line) or not (grey line).

5 Robustness Analysis

The robustness analysis focuses on which controls to include in the estimations, on which industries to include, and on which time periods to include. Throughout Table 3, the first-

[15] The standard errors of the specification in Column (6) of Table 2 and the remainder of the analysis are not adjusted for the fact that IPI-filtered is constructed. For specification in Column (6) of Table 2, this adjustment can be implemented via bootstrapping the filtering estimation in Column (6) of Table 1 and then estimating the 2SLS specification (6) of Table 2 over the various realizations of IPI-filtered. In practice, since the relation between the change in the USD/RMB exchange rate and import prices in the pre-2005 sample is estimated with very high precision (compare standard error and coefficient in Column (6) of Table 1), this approach only affects the estimated standard error up to the fifth decimal place.

stage results are reported in the lower Panel A, and the second-stage results are reported in the upper Panel B. In all of the first-stage specifications, the dependent variable is the change in the sector's IPI, which is filtered for the effect of the ROW exchange rate. In all of the second-stage estimations, the dependent variable is the change in the sector's PPI, which is also filtered for the effect of the ROW exchange rate.

Alternative Controls. It is not certain that the included measure of PPI inflation abroad is a relevant cost measure; rather, it might simply measure global inflationary pressure, which is correlated with US IPI and PPI. For that reason, Column (1) excludes this variable. Column (2) instead only controls for PPI inflation in China rather in the entire rest of the world.

In the pass-through regressions estimated in the literature, it is common to include the rate of domestic producer price inflation in the importing country as a general measure of price developments in the importer. As the rate of US producer price inflation is the dependent variable in the specifications estimated in this paper, including this variable in the first-stage estimation would obviously be spurious. However, it is still worthwhile to examine how the inclusion of a measure of US sectoral economic activity influences the results. Therefore, Column (3) includes the sectoral capacity utilization from the US Census "Survey of Plant Capacity Utilization" in the estimation.

The baseline specifications control for the overall Standard & Poor's Goldman Sachs Commodity Index as a proxy for the effect of commodity prices on US producer and importer prices. This index tracks the investment performance of all of the principal commodities that are traded in the commodity markets. Certain subcomponents of this index, particularly crude oil and other energy commodities, may disproportionately influence prices. Thus, the estimation in Column (4) includes, in addition to the main index, two commodity price sub-indices: the GSCI "Energy Commodity" and the GSCI "Metal Prices." In contrast, the estimation in Column (5) does not include a commodity index.

Import prices might mean-revert and it could also be the case that import prices have a lagged effect on producer prices. Column (6) adds two 6-month lags to the import price (i.e., the change in the price from -12 to -6 months and from -18 to -12 months) to the estimation. The estimation results imply that neither import nor producer prices substantially mean-revert.

Matching of Import and Producer Prices. The remainder of Table 3 examines whether the adopted matching of the BLS import price indices and producer prices (see appendix) affects the results. In the baseline specification, the sample is restricted to those 5-digit NAICS sectors to which an import price index at the 4-digit NAICS level of disaggregation can be allocated. In turn, all of the 5-digit import prices are allocated to the 6-digit PPI sector. Column (7) also uses those import prices to which a 3- or 2-digit NAICS IPI can be allocated to.

Instead of an analysis at the 6-digit level restricted to those 6-digit industries with underlying information on IPI, the estimation in Column (8) examines the relationships between the variables of interest at the 5-digit level of disaggregation. For this, information on producer prices at the 6-digit level is collapsed to the 5-digit level. The estimation thus includes 118 groups (as in Table 1).

Alternative Break Points and Structural Changes. The empirical strategy of this paper is to utilize the change in the Chinese exchange rate policy in mid-2005. A concern with this strategy is that there have also been structural changes in between the pre- and post-2005 period, such as the run-up in oil prices before and during 2008, the global financial crisis, or the great trade collapse that followed en-suite. In so far as these events also affect US import and producer prices and since they could be correlated with the timing of changes of the Chinese exchange rate, these events might lead to a bias in the uncovered coefficients.

Table 4 thus presents robustness test regarding potential structural breaks within the post-2005 period. In Columns (1) to (3), the sample covers the period from July 2005 to March 2011 and the estimation includes a dummy that is equal to one during the financial crisis (after August 2007; Column (1)), the oil price peak preceding the financial crisis (defined as the Oil price for US crude exceeding 80 USD/barrel; October 2007 to October 2008; Column (2)), and during the great trade collapse (August 2008 through April 2009; Column (3)), respectively.

A related concern is whether the within-sample relation between the USD/RMB exchange rate, import prices, and producer prices changed during these periods. Such within-period changes in the internal relations cannot be addressed by the inclusion of dummies. Instead, in each of the Columns (4) to (6), one of these respective time periods is excluded from the regression (pre-financial crisis in (4), oil price peak in (5), and great trade collapsed in (6)).

A further potential worry that is related to structural shifts is that the change in Chinese exchange rates could have followed a trend that is correlated with long-lasting structural shifts of either the US or the global economy. This concern should receive particular attention against the backdrop of the findings of Cheung et al. (2010 and 2011) that estimates of the elasticity of Chinese exports with respect to income growth abroad are highly sensitive to the in- or exclusion of a time trend. The estimation in Column (7) thus adds a trend to the estimation; while this trend is significant in both stages, addition of this variable has no effect on the first- and second-stage coefficients of interest.

6 Heterogeneous Pass-through Rates Across Sectors

The analysis of this section relates both the pass-through rate of the USD/RMB exchange rate into the US IPI and the pass-through rate of the US IPI into the PPI to various sector characteristics, such as the market share of Chinese imports, labor intensity, elasticity of demand, and the importance of traded intermediate goods in production. Doing so helps to clarify the microeconomics underlying how the exchange rate affects US domestic prices. Moreover, these exercises help to refine the simulations of the inflationary effect of a potential appreciation of the RMB presented in Section 7.[16]

[16] The specifications presented in this section are related to Feinberg (1986) and, in particular, to Feinberg (1989), who examines how the importance of the exchange rate for US domestic prices varies with sectoral characteristics.

Heterogeneity in the responses of producer prices to exchange rate changes may result from differences in the responses of import prices to the exchange rate or from differences in the responses of producer prices to import prices. Table 5 presents information from the first-stage coefficient – the response of the IPI to the USD/RMB exchange rate – in Panel A, while the second-stage coefficient relating the change in the IPI to US producer prices is presented in Panel B.

An obvious candidate for splitting the sample is the market share of Chinese imports. In order to ensure that the sample split is not driven by changes in the USD/RMB exchange rate itself, the 2005 market share of Chinese imports as a percentage of total consumption in the sector is used to split the sample.[17] The variable is constructed as follows

$$Market\ Share\ China_{2005,j} = \frac{Imports\ China_{2005,j}}{Imports\ World_{2005,j} + Domestic\ Production_{2005,j}},$$

where domestic production refers to all domestic output that is not exported. In Columns (1) and (2) of Table 5, the sample includes the sectors j with above-median Chinese market share (in (1)) and below-median Chinese market share (in (2)). The first-stage estimation in Panel A uncovers that the response to changes in the USD/RMB exchange rate is larger in sectors with a lower Chinese market share. In contrast, the second stage indicates that the rate of pass-through rate of the IPI into the PPI is higher in sectors with high import penetration.

It is noteworthy that both the result that exchange rate pass-through is decreasing in Chinese market share and the result that the rate at which import prices affect domestic prices is increasing in Chinese market share are consistent with a recent literature highlighting the importance of variable markups and price complementarities at the firm level. Most closely related to the result that higher Chinese import penetration is associated with lower pass-through is the analysis of Gust et al. (2010), who document that in the presence of variable markups, lower trade costs that are associated with higher market shares of importers imply higher and less variable markups. As these authors demonstrate, with higher trade integration, the degree of exchange rate pass-through thus decreases. Their purported importance of firm size for pass-through has received and empirical underpinning in a firm-specific micro study of Berman et al. (2012) who document that how a firm's market share affects the rate at which it reacts to changes in its own cost of production and by Auer and Schoenle (2014), who in addition document that market share matters for the rate at which firms react to competitor prices.

The theoretical frameworks underlying Gust et al. (2010) and Auer and Schoenle (2014) – who build on Dornbusch (1987), Feenstra et al. (1996), and Atkeson and Burstein (2008) – also imply that price complementarities are more important when trade integration is high: with more importers gaining a larger market share, the competitive environment in

[17]Using the 2005 market share thus ensures that the sample split in Columns (1) and (2) is constant throughout time. It should be noted that while China's export structure had changed substantially before 2003, thereafter the sectoral composition of Chinese exports remained rather stable (see, for example, Amiti and Freund (2010)); consequently, the sample split using 2005 market shares is very similar to splitting the sample using post-2005 market shares.

the industry depends more on the exchange rate, and as a consequence, the price response of domestic firms that are not affected by the initial exchange rate shock increases with trade integration. In the context of the empirical results of this paper, the variable markup channel thus also rationalizes why the degree to which the PPI reacts to the IPI is higher in sectors with higher Chinese market share (see panel B of Table 5).[18]

To further examine to which extent demand channels matter, in Columns (3) and (4), the sample is split by the elasticity of demand, taken from Broda and Weinstein (2006). The reaction of the IPI to the exchange rate is roughly the same across sectors with above- or below-median demand elasticity (see Panel A). However, the response of producer prices to the IPI is substantially larger in sectors with elastic demand than in those with inelastic demand (see Panel B). Given that the elasticity estimates of Broda and Weinstein (2006) are derived on a sectoral basis, they correspond to the sectoral demand elasticity (rather than the firm-specific elasticity) in the frameworks of Auer and Schoenle (2014) and Atkeson and Burstein (2008). In these frameworks, it holds that increasing the sectoral demand elasticity increases the degree of price complementarities, thus implying that also the results of Columns (3) and (4) are in line with such theories of price complementarities.

In addition to demand characteristics, also characteristics of the production technology might affect the rate of pass-through. The remainder of Table 5 therefore splits the sample by measures of each industry's intrinsic technological characteristics. Columns (5) and (6) document that the response of the IPI to the USD/RMB exchange rate is generally low in labor-intensive sectors. In Columns (5) and (6), the sample is split by the average labor intensity in the US, which is taken from Auer and Fischer (2010) and defined as the ratio of the expenditures on labor divided by the expenditures on capital.[19] The rate of pass-through into producer prices is higher in the sectors with relatively more capital expenditures relative to labor expenditures. The finding that exchange rate pass-through is higher in sectors that are more capital intensive seems counter-intuitive: since capital expenditures tend to be sunk and thus do not affect marginal costs, gross margins are high in capital-intensive industries. Because high gross margins leave more room for markup variability, this consideration would imply lower pass-through in capital-intensive industries. It must thus be the case that capital intensity is correlated with other industry characteristics that are causing pass-through to be low.

Columns (7) and (8) document that the prices of imported intermediate goods is a further key channel through which the RMB affects US domestic prices. In Columns (7) and (8), the sample is split by input intensity, a measure which is constructed based on Schott (2004) and described in the appendix. The estimation in Column (7) includes sectors that do not contain any intermediate goods (i.e., these sectors contain only final consumption goods). The estimation in Column (8) includes only the sectors with at least some intermediate goods. The sample is split up in this way as more than 50% of the

[18] See also Guerrieri et al. (2010) and Benigno and Faia (2010).

[19] The labor intensity measure should be constructed such that the variable reflects technological reasons to use more labor in some sectors than in other ones. Therefore, US industry information before December 2003 is used to construct the measure of labor intensity. This implicitly assumes that if in the years leading up to the end of 2003, the production of one good requires relatively more labor than the production of another good, the same is true after 2005.

observations do not contain any intermediate goods. The rate of pass-through into import prices is comparable in Columns (7) and (8). However, the response of producer prices to instrumented changes in import prices is larger in the sectors with intermediate goods. This finding is in line with Auer and Mehrotra (2014), who empirically show that fluctuations in the prices of imported inputs spill over into domestic prices.

Overall, the evidence in Table 5 thus points towards the importance of trade integration, variable markups, and demand complementarities on the one side, and towards the importance of imported intermediate goods on the other side to explain why the RMB exchange rate has such an pronounced effect on US domestic prices.

7 The Total Effect of an Appreciation

This section uses the findings from the above analysis to estimate the inflationary impulse of an appreciation of the RMB on US producer price inflation. For these predictions, I combine the previous findings and account for the fact that pass-through is heterogeneous along the dimensions of market share, input and labor intensity, and elasticity of demand. The simulations similarly account for the fact that exchange rate changes might affect producer prices only with a lag. Each sectoral pass-through rate is multiplied by the sector's weight in the official US PPI.[20]

Figure 6 presents the size of the total relative price shock in terms of the US PPI annual inflation rate. The solid line corresponds to a scenario in which the RMB appreciates for 10 months at a rate of 2.5% per month. That is, the solid line addresses the following counterfactual: what is the difference of the annual PPI inflation rate if the RMB appreciates by 2.5% per month as opposed to if the RMB/USD exchange rate does not change? This predicted impact on the US PPI peaks at approximately 4 percentage points near the end of the 10−months appreciation window. Figure 6 also presents a second scenario, where the RMB appreciates at 1% per month for 25 months.

Figure 6 documents that a RMB revaluation would result in a substantial impulse on the aggregate PPI. On theoretical grounds, however, it is not clear that such relative price shocks affect equilibrium inflation because price decreases by firms experiencing substantial import competition could be offset by price hikes in other parts of the economy. Ball and Mankiw (1995) note that in this context, one needs to evaluate the distribution of price shocks. Ball and Mankiw argue that in the presence of menu costs, firms adapt their prices to large external shocks but not to small shocks. Therefore, large shocks have disproportionate effects on the price level, and aggregate inflation depends on the distribution of relative-price changes such that inflation rises if the distribution is skewed to the right and falls if the distribution is skewed to the left.

Figure 7 examines the sectoral distribution of the price shocks that result from the RMB appreciation. The figure reports two univariate kernel density estimates when the RMB appreciates by 25% over either 10 months (solid line) or over 25 months (dashed line). The

[20]Because the total weight of the sectors included in this study is less than 30% of the PPI, the magnitude of the overall effects as a percentage of the PPI is much smaller (approximately a third) than suggested by the coefficients in the above analysis.

size of the monthly price shock in each sector is measured as a percentage and is displayed on the horizontal axis, while the density (in sector-months observations) is displayed on the vertical axis. Figure 7 covers the 30 months after the appreciation and reveals that a rapid appreciation (2.5% per month) would lead to a strongly right-skewed distribution of relative price shocks. Thus, the considerations along the line of Ball and Mankiw (1995) imply that at this pace, an RMB-revaluation is likely to also affect the US aggregate PPI inflation. Interestingly, the effect on the distribution of relative price shocks is much more contained when the RMB increases at 1% per month.

8 Conclusion

The course of US inflation over the next years may be closely intertwined with the resolution of global imbalances. The rise of cheap imports from China was a major contributor to the low-inflation environment during the last decade. Auer and Fischer (2010) show that the rise of import competition from low-wage countries has decreased US inflationary pressure by approximately half a percentage point during the last decade. The latter study also documents that this effect was primarily due to the rise of China.

If an appreciation of the RMB is aimed at restoring a balanced US-Chinese current account and is successful in doing so, the disinflationary effect will likely be reversed. The analysis of this paper quantifies the relative price shock resulting from an RMB revaluation using an estimation technique that takes into account that the Chinese government followed other exchange rates when the RMB appreciated, then investigates the response of import prices to the RMB/dollar exchange rate and, in a third step, estimates the resulting response of US producer prices.

This analysis finds much more pronounced effects than is commonly assumed. For example, in a sample spanning 418 US manufacturing sectors, the rates of pass-through of import prices into US producer prices is estimated to equal 0.7. Simulations that take into account that the rate of pass-through is heterogeneous across sectors and that the timing of the pass-through into producer prices matters reveal that a substantial revaluation of the RMB would result in a substantial upward impulse on the prices of US goods.

Researchers and policymakers are primarily worried that external adjustments from the US could create economic problems outside of the US (see, for example, Kamin et al. (2007)). I show that the US economy could actually be adversely affected if the external adjustment is achieved via a drastic RMB revaluation. US policymakers should consider these possibilities when deciding their course of action regarding the trade policy with China.

References

[1] Amiti, Mary and Caroline Freund, 2010. "The Anatomy of China's Export Growth,"NBER Chapters, in: China's Growing Role in World Trade, pages 35-56 National Bureau of Economic Research, Inc.

[2] Amiti, Mary, Oleg Itskhoki, and Jozef Konings (2014): "Importers, Exporters and Exchange Rate Disconnect," American Economic Review, July 2014, 104(7): 1942-1978.

[3] Atkeson, Andrew and Ariel Burstein, "Pricing to Market, Trade Costs, and International Relative Prices,", *American Economic Review*, December 2008.

[4] Auer, Raphael A. and Thomas Chaney (2009). "Exchange Rate Pass-Through in a Competitive Model of Pricing-to-Market." *Journal of Money, Credit and Banking*, 41 (s1): 151–175.

[5] Auer, Raphael A., Thomas Chaney and Philip Saure "Quality Pricing-to-Market", CEPR DP 10053, July 2014.

[6] Auer, Raphael A., K., Degen and A. M. Fischer, 2013. "Low-wage import competition, inflationary pressure, and industry dynamics in Europe" *European Economic Review*, 59 (C), pages 141-166. March 2013.

[7] Auer, Raphael A. and A. M. Fischer, (2010). The effect of low wage import competition on US inflationary pressure, *Journal of Monetary Economics* 57(4), 491-503.

[8] Auer, Raphael A., Andrei A. Levchenko and Philip Saure "Price Spillovers via the global supply chain", Mimeo, SNB, December 2014.

[9] Auer, Raphael A. and Aaron Mehrotra (2014) "Trade linkages and the globalisation of inflation in Asia and the Pacific," Vol 49: pp. 129-151, *Journal of International Money and Finance*, December 2014.

[10] Auer, Raphael A. and R. Schoenle, (2014) "Market structure and exchange rate pass-through", Mimeo, Brandeis University.

[11] Autor, David H., David Dorn, and Gordon H. Hanson, (2013). "The China Syndrome: Local Labor Market Effects of Import Competition in the United States," American Economic Review, American Economic Association, vol. 103(6), pages 2121-68, October.

[12] Bacchetta, Philippe and Eric van Wincoop, 2003. "Why Do Consumer Prices React Less Than Import Prices to Exchange Rates?," Journal of the European Economic Association, MIT Press, vol. 1(2-3), pages 662-670, 04/05.

[13] Ball, L. and N.G. Mankiw, (1995). "Relative-price changes as aggregate supply shocks", Quarterly Journal of Economics 110 (1) (1995), pp. 163–193.

[14] Benigno, Pierpaolo and Ester Faia (2010) "Globalization, Pass-Through and Inflation Dynamic," NBER Working Paper No. 15842, March 2010.

[15] Bergin, Paul R. and Robert Feenstra, (2001) "Pricing-to-market, staggered contracts, and real exchange rate persistence". Journal of International Economics, 54 (2001), pp. 333–359.

[16] _ _ (2009) "Pass-through of Exchange Rates and Competition Between Floaters and Fixers, (2009). *Journal of Money Credit and Banking* 41 (1), 35-70.

[17] Berman, Nicolas, Philippe Martin, and Thierry Mayer, (2012). "How do Different Exporters React to Exchange Rate Changes?," The Quarterly Journal of Economics, Oxford University Press, vol. 127(1), pages 437-492.

[18] Bloom, Nicholas, Mirko Draca, and John Van Reenen. 2011. "Trade-Induced Technical Change? The Impact of Chinese Imports on Diffusion, Innovation, and Productivity." NBER Working Papers 16717, National Bureau of Economic Research, Inc.

[19] Bosworth, B (2004). Valuing the renminbi. Paper presented at the Tokyo Club Research Meeting, 9–10 February.

[20] Broda, Christian, and David Weinstein. (2006). "Globalization and the Gains from Variety." *The Quarterly Journal of Economics*, 121 (2): 541–585.

[21] Bugamelli, M., S. Fabiani, and E. Sette, 2010. The pro-competitive effect of imports from China: an analysis of firm level price data, Temi di discussione 737, Bank of Italy.

[22] Bureau of Labor Statistics (2010), BLS Handbook of Methods, Chapter 14 "Producer Prices, Background".

[23] Burstein, Ariel, Joao Neves, and Sergio Rebelo, "Distribution Costs and Real Exchange Rate Dynamics during Exchange Rate Based Stabilizations," Journal of Monetary Economics 50:6 (September 2003), 1189–1214.

[24] Campa, José Manuel and Linda S. Goldberg (2005). "Exchange Rate Pass Through into Import Prices," Review of Economics and Statistics, 87:4 (2005), 679–690.

[25] Chen, Natalie, Jean Imbs and Andrew Scott "The Dynamics of Trade and Competition", Journal of International Economics, February 2009, Vol. 77(1), pp.50-62.

[26] Cheung, Y, M Chinn, and E Fujii (2010), "China's Current Account and Exchange Rate", in R Feenstra and S-J Wei (eds.), China's Growing Role in World Trade, University of Chicago Press.

[27] Cheung, Y., M. Chinn and X. Qian (2011), "Are Chinese Trade Flows Different?", Paper presented at the JIMF 4th Annual Conference at UC Santa Cruz.

[28] CHINN, Menzie D., Barry EICHENGREEN and Hiro ITO, (2013). "A Forensic Analysis of Global Imbalances," Oxford Economic Papers, 66 (2), pp. 465-490.

[29] CHINN, Menzie D. and Shang-Jin WEI, (2013). "A Faith-Based Initiative Meets the Evidence: Does a Flexible Exchange Rate Regime Really Facilitate Current Account Adjustment?" The Review of Economics and Statistics, MIT Press, vol. 95(1), pages 168-184, March.

[30] CORSETTI, Giancarlo and Luca DEDOLA, "Macroeconomics of International Price Discrimination," Journal of International Economics 67 (2005), 129–156.

[31] DEVEREUX, Michael B. and Charles ENGEL, "Exchange Rate Pass-Through, Exchange Rate Volatility, and Exchange Rate Disconnect," Journal of Monetary Economics 49 (2002), 913–940.

[32] DORNBUSCH, Rudiger (1987). "Exchange Rates and Prices," *The American Economic Review*, Vol. 77, No. 1., pp. 93-106. March 1987.

[33] FEENSTRA, Robert C., GAGNON, Joseph E. and KNETTER, Michael M., 1996. "Market share and exchange rate pass-through in world automobile trade," Journal of International Economics, Elsevier, vol. 40(1-2), pages 187-207, February.

[34] FEINBERG, Robert M (1986): "The Interaction of Foreign Exchange and Market Power Effects on German Domestic Prices". Journal of Industrial Economics, Vol. 35, No. 1, pp. 61-70.

[35] FEINBERG, Robert M (1989): "The Effects of Foreign Exchange Movements on US Domestic Prices". Review of Economics and Statistics, Vol. 71, No. 3, pp. 505-11.

[36] FRANKEL, Jeffrey (2009), "New Estimation of China's Exchange Rate Regime", Pacific Economic Review ,14(3):346-360, August.

[37] _ _ (2010), "The renminbi since 2005." Colunmn, VoxEU.org, Published on 16 April 2010

[38] FRANKEL, J. A., D. C. Parsley, and S.-J. Wei (2005): "Slow Passthrough Around the World: A New Import for Developing Countries?," NBER Working Paper 11199.

[39] FRANKEL, Jeffrey and Shang-Jin.WEI (2007), "Assessing China's Exchange Rate Regime", Economic Policy, 51:575-614.

[40] _ _ (2008), "Estimation of De Facto Exchange Rate Regimes: Synthesis of the Techniques for Inferring Flexibility and Basket Weights", IMF Staff Papers 55:384-416.

[41] GAGNON, Etienne, Benjamin R. MANDEL, and Robert J. VIGFUSSON, 2014. "Missing Import Price Changes and Low Exchange Rate Pass-Through," American Economic Journal: Macroeconomics, American Economic Association, vol. 6(2), pages 156-206, April.

[42] GEITHNER, Thimothy E. (2009), Remarks made at the Public Confirmation hearing by the US Senate Finance Committee on January 21st, 2009.

[43] GOLDBERG, Linda S. and José Manuel CAMPA (2010). "The Sensitivity of the CPI to Exchange Rates: Distribution Margins, Imported Inputs, and Trade Exposure" Review of Economics and Statistics, May 2010, Vol. 92, No. 2: 392–407.

[44] GOLDBERG, Linda S. and TILLE, Cédric, 2008. "Vehicle currency use in international trade," Journal of International Economics, Elsevier, vol. 76(2), pages 177-192, December

[45] GOLDBERG, Pinelopi K. and Frank VERBOVEN (2001). "The Evolution of Price Dispersion in European Car Markets", Review of Economic Studies, Oct. 2001, pp. 811-48.

[46] GOPINATH, Gita, Oleg ITSKHOKI (2010). "Frequency of Price Adjustment and Pass-through". Quarterly Journal of Economics, May 2010, Volume 125(2).

[47] _ _ (2011): "In Search of Real Rigidities," NBER Macroeconomic Annual 2010, Daron Acemoglu and Michael Woodford, editors, University of Chicago Press, May 2011, Volume 25, pp. 261-309.

[48] GOPINATH, Gita, Oleg ITSKHOKI, and Roberto RIGOBON (2010b) "Currency Choice and Exchange Rate Pass-through" American Economic Review, March 2010, Volume 100(1).

[49] GOPINATH, Gita and Roberto RIGOBON (2008). "Sticky Borders", Quarterly Journal of Economics, May 2008, Volume 123(2).

[50] GUERRIERI, Luca, GUST, Christopher, and David LOPEZ-SALIDO (2010) "International Competition and Inflation: A New Keynesian Perspecitve" , American Economic Journal: Macroeconomics, vol. 2 (October 2010), pp. 247-280

[51] GUST, Christopher, Sylvain LEDUC and Roger VIGFUSSON "Trade Integration, Competition, and the Decline in Exchange-Rate Pass-Through", Journal of Monetary Economics 57, April 2010, 309-324.

[52] HOLZ, Carsten A and Aaron MEHROTRA, 2013. "Wage and price dynamics in a large emerging economy: The case of China," BIS Working Papers 409, Bank for International Settlements.

[53] INTERNATIONAL MONETARY FUND (2008), World Economic Outlook, 2008. How has globalization affected inflation?, Chapter 3, 97-134.

[54] JOHNSON, Robert C. and NOGUERA, Guillermo, 2012. "Accounting for intermediates: Production sharing and trade in value added," Journal of International Economics, Elsevier, vol. 86(2), pages 224-236.

[55] Kamin, Steven B., Trevor A. Reeve, and Nathan Sheets (2007). "US External Adjustment: Is It Disorderly? Is It Unique? Will It Disrupt the Rest of the World?" International Finance Discussion Papers, Federal Reserve Board, 2007-892 (April 2007).

[56] _ _ (1993)."International Comparisons of Price-to-Market Behavior," Amer. Econ. Rev., June 1993, 83(3), pp. 473-86.

[57] Kim, Mina, Deokwoo Nam, Jian Wang, and Jason Wu (2013). "International Trade Price Stickiness and Exchange Rate Pass-through in Micro Data: A Case Study on US-China Trade" Globalization and Monetary Policy Institute Working Paper No. 135, Federal Reserve Bank of Dallas, revised August 2013

[58] Koopman, Robert, Zhi Wang, Shang-Jin Wei, 2014. "Tracing Value-Added and Double Counting in Gross Exports," American Economic Review, American Economic Association, vol. 104(2), pages 459-94, February.

[59] Marazzi, Mario and Nathan Sheets, 2007. "Declining exchange rate pass-through to US import prices: The potential role of global factors," Journal of International Money and Finance, Elsevier, vol. 26(6), pages 924-947, October.

[60] Marazzi,Mario, Nathan Sheets, Robert J.Vigfusson, Jon Faust, Joseph E. Gagnon, Jaime R.Marquez, Robert F. Martin, Trevor Reeve, and John H. Rogers. 2005. "Exchange Rate Pass-Through to US Import Prices: Some New Evidence." Board of Governors of the Federal Reserve System International Finance Discussion Papers, no. 833,April.

[61] Nakamura, Emi and Jón Steinsson (2012) "Lost in Transit: Product Replacement Bias and Pricing to Market." American Economic Review 102 (7): 3277–3316.

[62] Nakamura, Emi and Dawit Zerom (2010) "Accounting for Incomplete Pass-Through" Review of Economic Studies, 77(3), 1192-1230, July 2010.

[63] Neiman, Brent, 2010. "Stickiness, synchronization, and passthrough in intrafirm trade prices," Journal of Monetary Economics, Elsevier, vol. 57(3), pages 295-308, April

[64] Overholt, William. (2003) "Exposing the Myths," South China Morning Post, November 17, 2003.

[65] Pennings, Steven (2013). "Reacting to the Wrong Exchange Rate", Mimeo, New York University

[66] Rynn, Jonathan M. "Why Manufacturing and the infrastructure are central to the economy: A global vision of peace, prosperity, democracy, and ecological sustainability" posted on www.economicreconstruction.com on 11/1/2005.

[67] Schott, Peter K. (2004). "Across-product versus within-product specialization in international trade." *The Quarterly Journal of Economics*, 119 (2): 647–678.

[68] VIGFUSSON, R.J., SHEETS, N.,GAGNON, J. ,2009. "Exchange rate pass through to export prices: assessing cross-country evidence." Review of International Economics 17,17–33.

9 Appendix

9.1 Sectoral US Import and Producer Prices

The sample of this paper covers US import and producer prices in a monthly panel dataset spanning the years from January 1994 to December 2010 and including 418 different sectors in a baseline estimation and up to 516 sectors in total. Trade data by sector and quarter are obtained from the United States International Trade Commission (USITC). The import data are classified based on the 6−digit North American Industry Classification System (NAICS). The General Customs Value is selected as the trade type.

Information on import prices is available from the Bureau of Labor Statistics (BLS) at various levels of aggregation. There are 55 import price indices at the 5−digit level, 64 at the 4−Digit level, and 21 at the 3−digit level. To guarantee that all of the prices used in the analysis below are independent observations, I use the 55 price indices at the 5−digit level and add to this the 4− or 3−digit prices for which either no 5−digit price is published or for which I can compute more 5-digit prices based on the difference between the import price indices at the 5−digit and 4−digit levels considering the respective import weights of index and sub-indices.

For example, if sector 1234 has two 5−digit subsectors $1234A$ and $1234B$, and if a 5−digit price index is published for the 4−digit sector and for one 5−digit subsectors (e.g., $1234A$), it is possible to construct the price index for subsector $1234B$ using the first order approximation

$$\Delta IPI_{1234}w_{1234} = \Delta IPI_{1234A}w_{1234A} + \Delta IPI_{1234B}w_{1234B}$$

where w_{1234}, w_{1234A}, and w_{1234B} are the import shares of the respective 5− or 4−digit sectors. I also use the same assignment process to allocate the information available at the 3−digit level to the missing 4−digit prices.

Information on producer prices is available from the BLS at the 6- and 5-digit level for all of the sectors for which import prices are available.

Information on sector characteristics, such as labor intensity or the sector's general openness to trade, is included in the data. This information is obtained from the Annual Survey of Manufacturers. This data restrict the analysis to manufactured goods (NAICS codes 311111 to 339999), as only these sectors are covered in the Annual Survey of Manufacturers.

The overlap of trade information from the USITC, information from the Annual Survey of Manufacturers, and price information from the BLS yields 118 sectors (at the 5−digit level) when working with import prices, and 418 sectors when working with producer prices to which these 5-digit levels can be allocated to.

9.2 Other Controls

A trade-weighted exchange rate index (or trade-weighted ROW exchange rate index that excludes China) is constructed using exchange rates from the IMF's IFS database and annual US trade weights constructed from the USITC trade data. To control for changes in the production costs abroad in the PT regressions, I construct the trade-weighted PPI inflation abroad (or in the ROW) by using the IFS PPI data and the USITC trade weights. For both trade-weighted indices (PPI inflation and exchange rate), I use the one-year lag of the import weights to ensure that these indices are not biased by a contemporaneous correlation between the volume of trade and other macro variables.[21]

$$\Delta e_{USD/ROW_t} = \sum_{\text{all j}\neq China} w_{j,t}\Delta e_{USD/CUR_{j,t}}$$

$$w_{j,t} = \frac{\text{Imports from j}_{t-1}}{\text{World Imports}_{t-1}\text{ - Imports from China}_{t-1}}$$

Three indices of commodity prices are added as controls. In the main specification, the overall Standard & Poor's Goldman Sachs Commodity Index (GSCI) is used to control for changes in commodity prices. This index tracks the investment performance (measured in USD) in the commodity markets and is calculated on a global production-weighted basis of all principal commodities that are traded on the markets. Two sub-indices, the GSCI "Energy Commodity" and the GSCI "Metal Prices", are also used.

Last, as a measure of sectoral economic activity, the capacity utilization from the US Census' "Survey of Plant Capacity Utilization" is included in the sample. This variable is available on a quarterly basis for 102 manufacturing and publishing sectors (up to the 6−digit NAICS level of disaggregation).

9.3 Monthly PPI index for China

Although the National Bureau of Statistics China, the official statistical office, does publish a monthly series related to producer prices, the precise form in which this series is published makes it impossible to measure the exact monthly change in producer prices. Instead of publishing a series of monthly producer price changes or levels, the National Bureau of Statistics China reports a 12-month rolling sum of monthly producer price changes. At every point t, $\Delta PPI_{China,t,t-12}$, the 12 months sum of monthly price changes is equal to:

$$\Delta PPI_{China,t,t-12} = \sum_{k=1}^{12} \Delta PPI_{China,t-k+1,t-k}$$

If PP inflation is constant, it holds that $\Delta PPI_{China,t,t-12} = 12 * \Delta PPI_{China,t,t-1}$. However, if monthly inflation fluctuates, the monthly change in this rolling average $\Delta PPI_{China,t,t-12}$ is equal to

$$\Delta PPI_{China,t,t-12} - \Delta PPI_{China,t-1,t-13} = \Delta PPI_{China,t,t-1} - \Delta PPI_{China,t-12,t-13}$$

so that it holds

$$\Delta PPI_{China,t,t-1} = \Delta PPI_{China,t,t-12} - \Delta PPI_{China,t-1,t-13} + \Delta PPI_{China,t-12,t-13}$$

[21] The trade-weighted arithmetic average of global PPI inflation is sensitive to hyperinflation. Thus, the trade-weighted median PPI inflation is used in the analysis.

Without further information (on $\Delta PPI_{China,t-12,t-13}$ in this example and the 12 initial values of monthly price changes in general), it is impossible to construct a monthly series of price changes from the published 12−months rolling average inflation rate. The monthly rate is thus approximated by:

$$\Delta PPI_{China,t,t-1} = \frac{\Delta PPI_{China,t,t-12}}{12} + \left[\Delta PPI_{China,t,t-12} - \Delta PPI_{China,t-1,t-13}\right]. \quad (6)$$

Which assumes that on average, $\Delta PPI_{China,t-12,t-13}$ is equal to $\frac{\Delta PPI_{China,t,t-12}}{12}$. In the main text, the 3-month cumulative change is constructed from the following formula in (6)

9.4 Sector Characteristics

Labor Intensity. The average labor intensity in the US is taken from Auer and Fischer (2010) and defined as the ratio of the expenditures on labor divided by the expenditures on capital. Auer and Fischer use the information from the BLS annual survey of manufacturing to calculate the expenditures on capital. They also average the labor intensity throughout time such that the resulting variable does not vary over time within a NAICS 5- or 6-digit sector.

$$Labor\ Intensity_j = \frac{\sum_{97-03} US\ Labor\ Expenditures_j}{\sum_{97-03} US\ Capital\ Expenditures_j}$$

Intermediate Goods. The input intensity measure is constructed based on Schott (2004). In Schott (2004), trade flows at the 10-digit Harmonized System (HS) that contain words such as "output", "part", and "intermediates" in the good description are classified as containing intermediate goods. The resulting dummy is subsequently aggregated to the 6-digit NAICS level taking into account the weight of each 10-digit HS good in the respective 6-digit NAICS sector. The resulting variable measures the volume-weighted fraction of the 10-digit HS goods within a 6-digit NAICS sector that includes intermediate goods. Thus, the variable can take any value between 0 and 1.

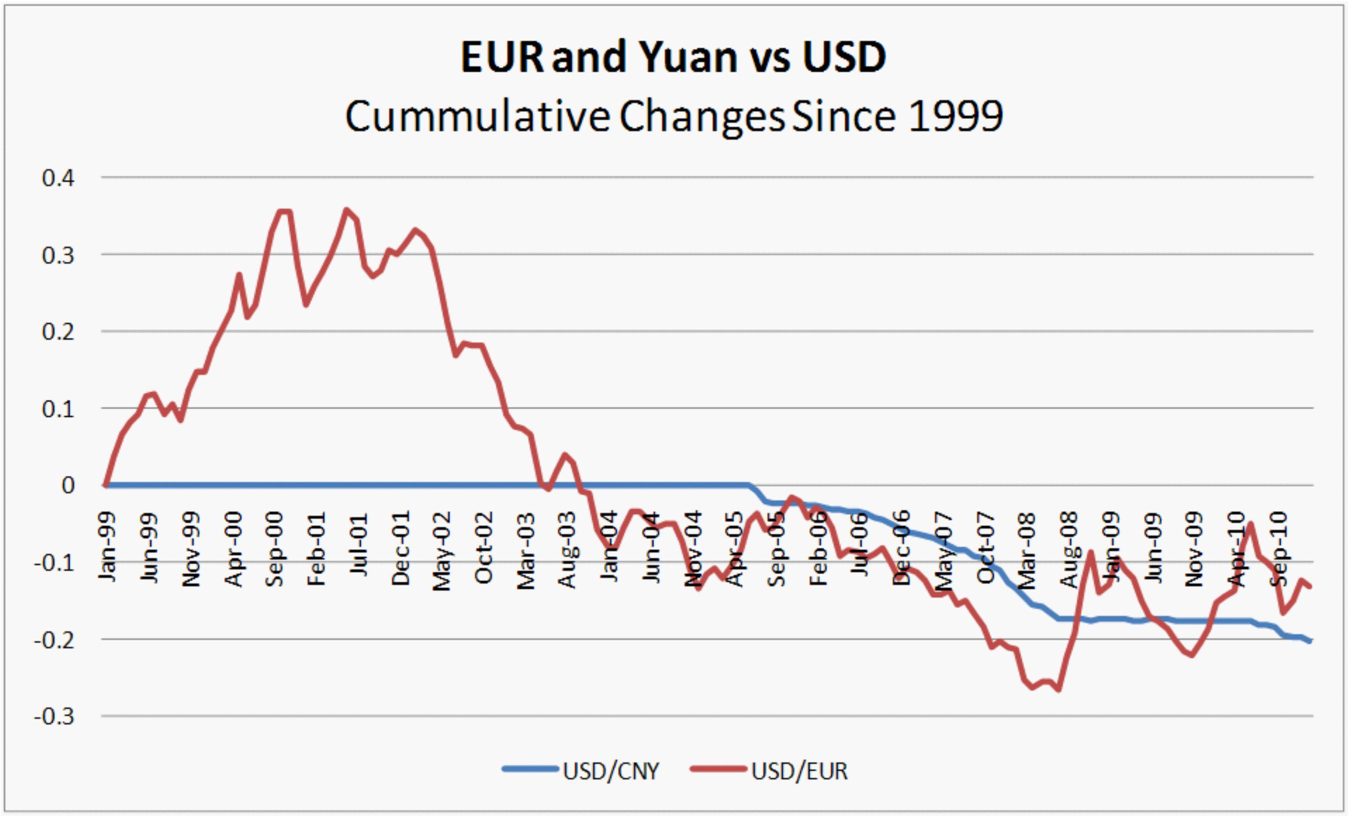
EUR and Yuan vs USD
Cummulative Changes Since 1999
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
Jan-99
Jun-99
Nov-99
Apr-00
Sep-00
Feb-01
Jul-01
Dec-01
May-02
Oct-02
Mar-03
Aug-03
Jan-04
Jun-04
Nov-04
Apr-05
Sep-05
Feb-06
Jul-06
Dec-06
May-07
Oct-07
Mar-08
Aug-08
Jan-09
Jun-09
Nov-09
Apr-10
Sep-10
USD/CNY
USD/EUR

Figure 1

Figure 2: The Renminbi, Prices of Imports from China, and US PPI Inflation

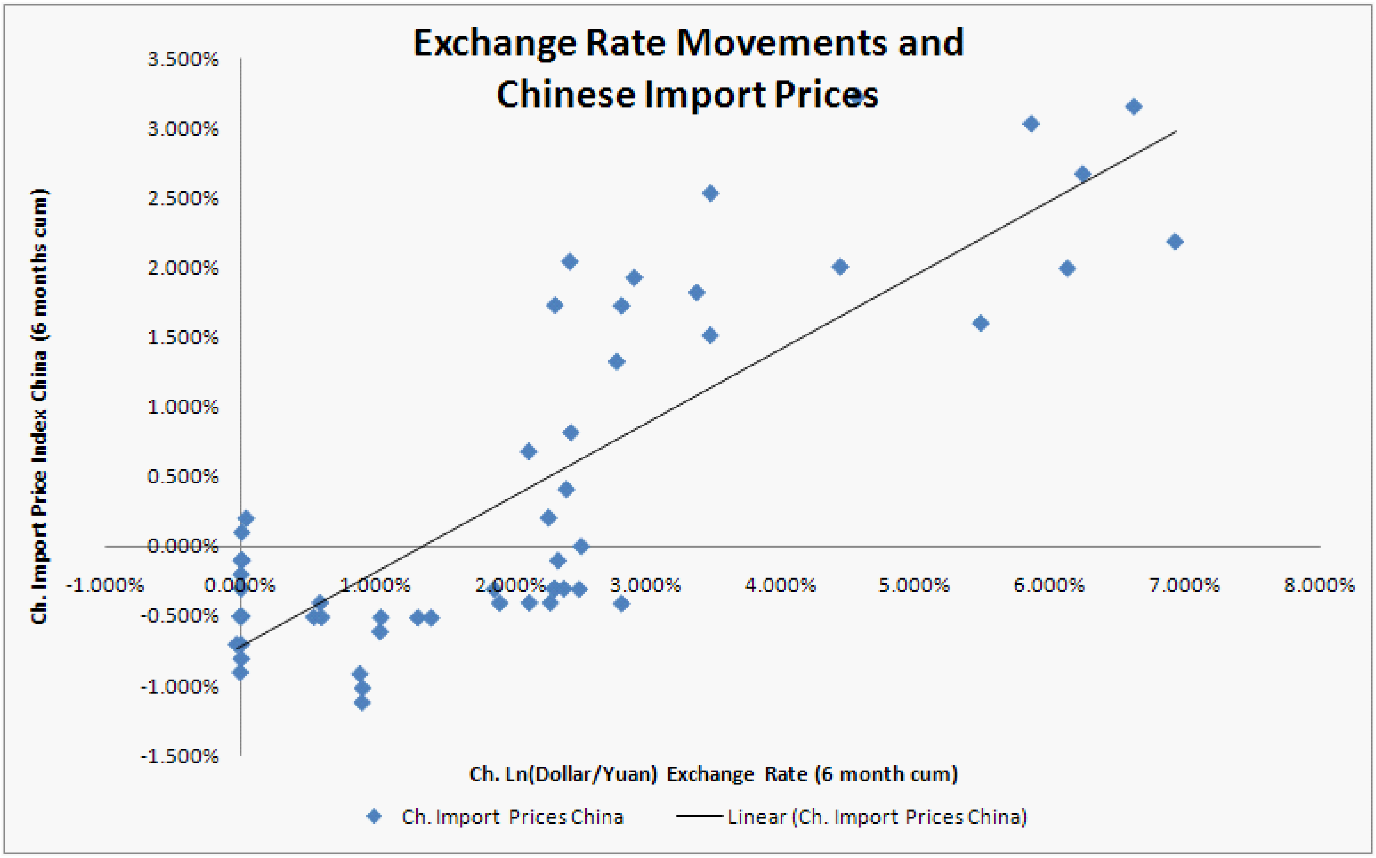
Exchange Rate Movements and
Chinese Import Prices
3.500%
3.000%
2.500%
2.000%
1.500%
1.000%
0.500%
0.000%
-0.500%
-1.000%
-1.500%
-1.000%
0.000%
1.000%
2.000%
3.000%
4.000%
5.000%
6.000%
7.000%
8.000%
Ch. Import Price Index China (6 months cum)
Ch. Ln(Dollar/Yuan) Exchange Rate (6 month cum)
Ch. Import Prices China
Linear (Ch. Import Prices China)

Figure 3

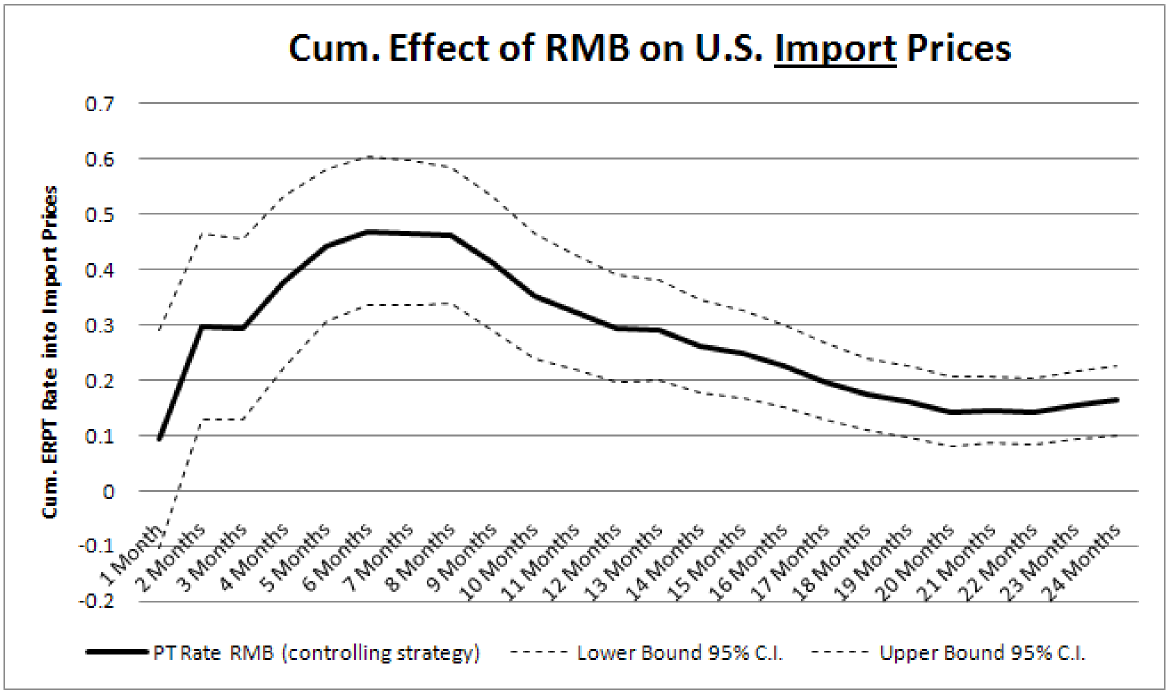

Figure 4

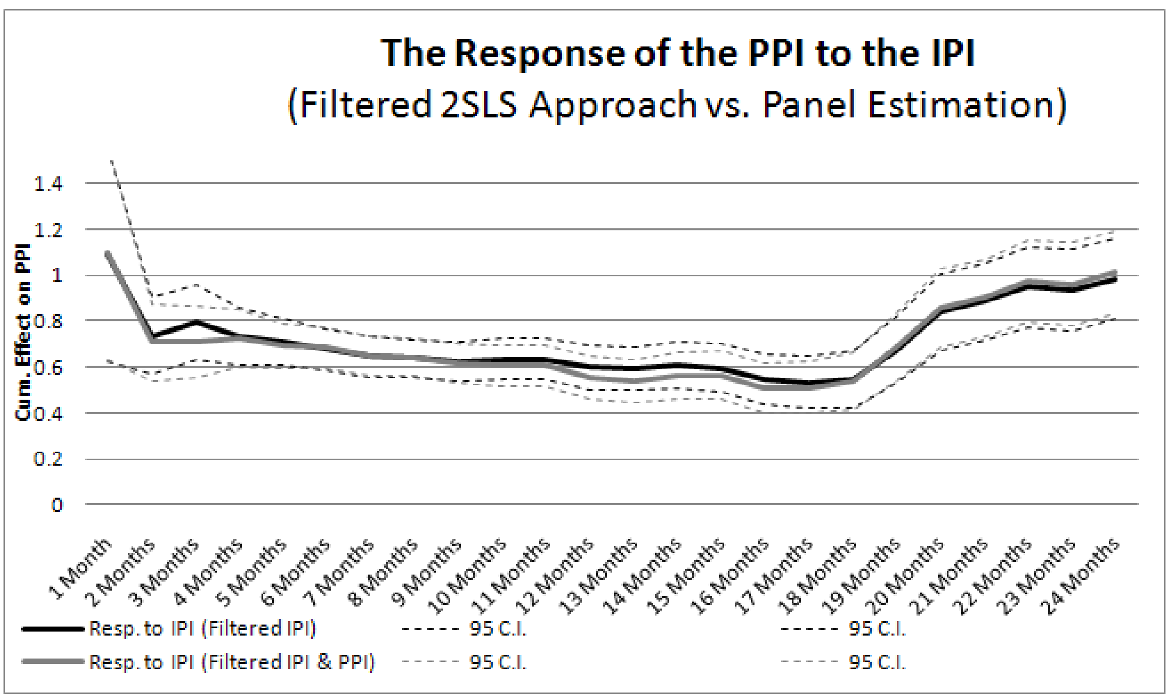

Figure 5

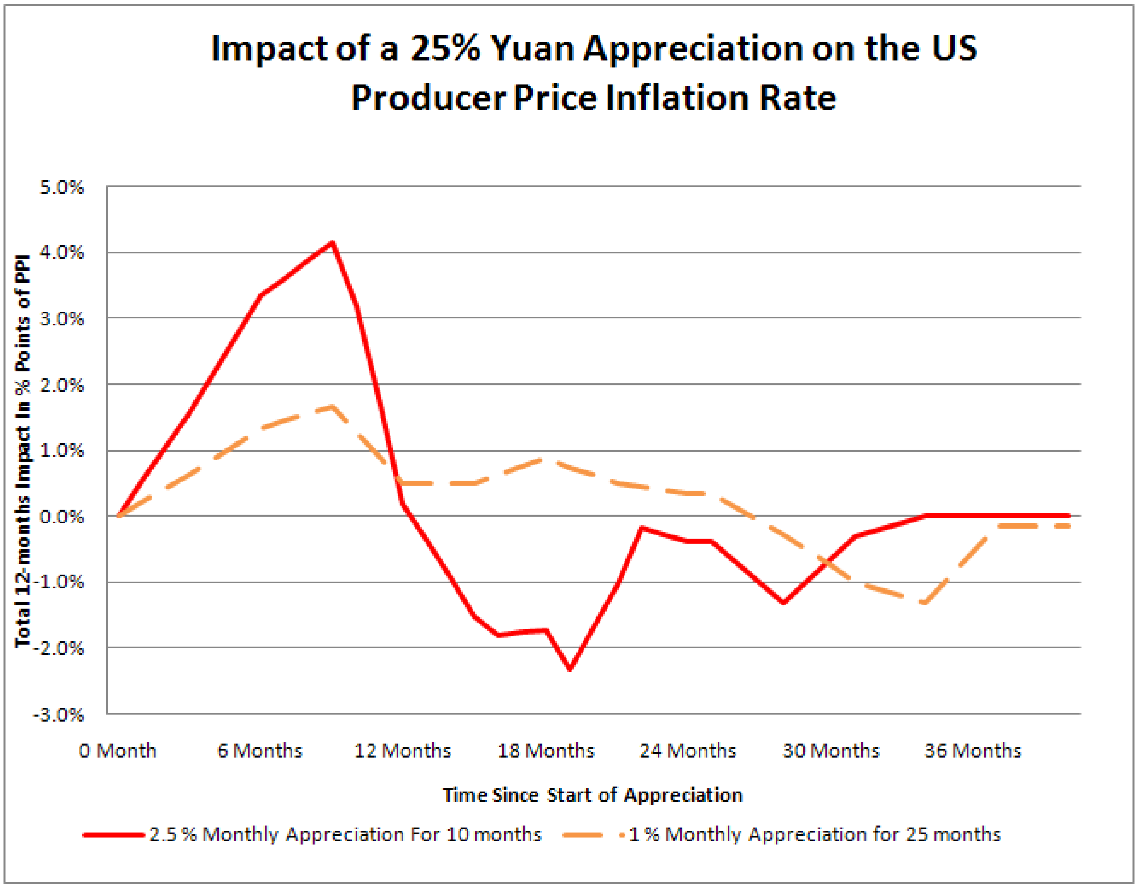
Impact of a 25% Yuan Appreciation on the US Producer Price Inflation Rate
Total 12-months Impact In % Points of PPI
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
-1.0%
-2.0%
-3.0%
0 Month
6 Months
12 Months
18 Months
24 Months
30 Months
36 Months
Time Since Start of Appreciation
2.5 % Monthly Appreciation For 10 months
1 % Monthly Appreciation for 25 months

Figure 6

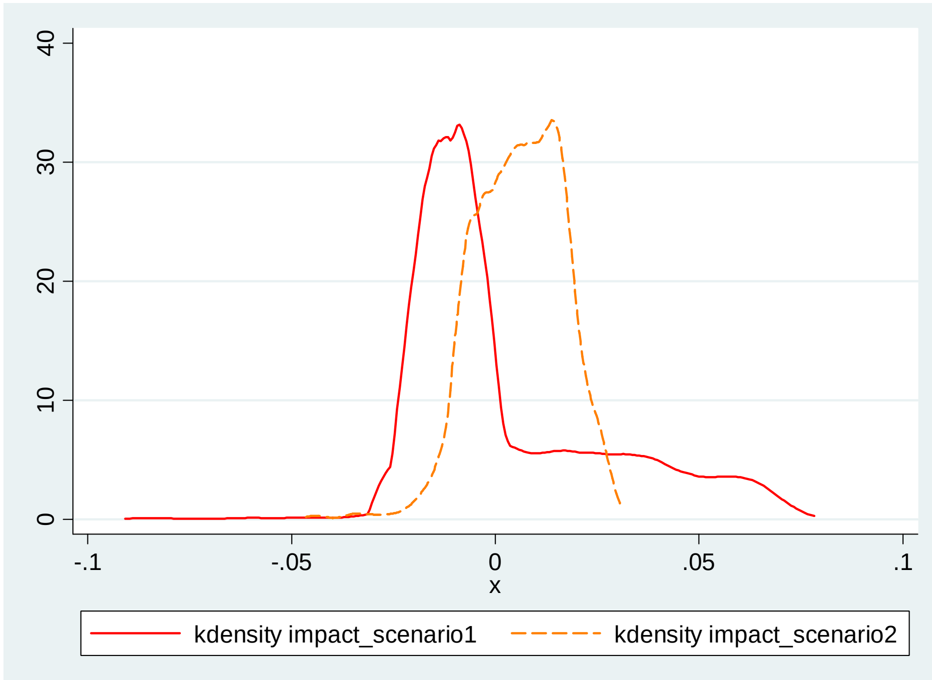

Figure 7 - Revaluation of the renminbi and the distribution of US price changes.

Table 1 - Response of U.S. Import Prices to RMB and other Exchange Rate Movements (FE Panel Estimations)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Unconditional Correlation	*Controls*	*controlling for OECD Exrate*	*7 Large Trade Partners Exr*	*PPI Dynamics China*	*pre 2005*	*post 2005, filtered*
Sample:			*(1)-(5): After June 2005*			*Before June 2005*	*After June 2005*
Dependent Variable			**(1)-(6): Ch. in U.S. Import Price Index at the NAICS 5-Digit Level**				**Ch. in Filtered IPI**
Change USD/RMB	0.563	0.245	0.24	0.3			0.292
	[0.066]***	[0.085]***	[0.085]***	[0.130]**			[0.083]***
Ch. USD/RMB + PPI Infl. China					0.286		
					[0.065]***		
Change USD/ROW Exrate		0.072	0.105	0.138	0.07	0.147	
		[0.027]***	[0.036]***	[0.040]***	[0.027]***	[0.004]***	
Ch. Commodity Prices		0.047	0.048	0.036	0.04		0.037
		[0.006]***	[0.006]***	[0.007]***	[0.007]***		[0.005]***
Avg. PPI Inflation in Trade Partners		-0.002	0.001	-0.006	-0.007		-0.012
		[0.020]	[0.020]	[0.022]	[0.020]		[0.019]
Change USD/Non-OECD Exrate			0.056	-0.085			
			[0.039]	[0.200]			
Change USD/CAD				0.099			
				[0.027]***			
Change USD/EUR				0.141			
				[0.089]			
Change USD/MXN				-0.051			
				[0.029]*			
Change USD/JPY				-0.024			
				[0.023]			
Change USD/KRW				-0.067			
				[0.033]**			
Change USD/VEB				-51.202			
				[29.639]*			
Change USD/SAR				-2.127			
				[2.87]			
Observations	6708	5877	5877	5877	5877	13605	5877
Number of Groups	118	118	118	118	118	118	118
R-squared (Overall)	0.02	0.05	0.05	0.05	0.05	0.11	0.03

Notes: Table 1 presents the results of fixed effects panel estimations relating the US-Chinese exchange rate to U.S. import prices. All changes refer to cumulated 3-months changes and all specifications include seasonality dummies (monthly). In (1)-(5) and (7), the sample covers the time from July 2005 to March 2011 and in (6), the sample covers the period from January 1995 to June 2005. In (1)-(6), the dependent variable is the change in the sectoral US IPI , while in (7) the dependent variable is the change in the "Filtered IPI", equivalent to the residual of the out-of-sample prediction of the model estimated in (6) (see main text). The variables change in USD/ROW exchange rate is calculated on a trade-weighted basis using one year lagged import shares (all imports except China) as weights. The variable PPI Inflation in trade partners is calculated using the same weights within all US trade partners. Change USD/Non-OECD exchange rate is calculated using the same weights within the sample of Non-OECD members (except China). “Ch. USD/Yuan + PPI Infl. China” is equal to the sum of the change in the USD/RMB exchange rate and domestic PPI inflation in China; Standard errors in brackets; * significant at 10%; ** significant at 5%, *** significant at 1%.

Table 2 - Pass-Through of Import Prices Into Producers Prices: OLS vs. 2SLS Estimations (FE Panel Estimations)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
								(8 A)	(8 B)
	OLS Correlation		OLS w. Controls		Filtered IPI	IV w/o filtered	(6) adding	Filtering PPI	Filtered PPI
Sample	pre 2005	post 2005	pre 2005	post 2005		IPI	ROW as test	pre 2005	post 2005
Estimation Type:	FE Panel	FE Panel	FE Panel	FE Panel	FE Panel	Panel IV	Panel IV	FE Panel	Panel IV
Dependent Variable				**(1)-(7) & (8A): Ch. PPI**					**Filtered PPI**
				Second-Stage Estimation					
Change IPI	0.111	0.349	0.132	0.349			**0.843**		
(**bold** indicates 2SLS coefficient)	[0.054]**	[0.057]***	[0.062]**	[0.060]***			**[0.208]*** **		
Change IPI, Filtered					0.35	**0.8**			**0.712**
(**bold** indicates 2SLS coefficient)					[0.071]***	**[0.178]*** **			**[0.080]*** **
Ch. USD/ROW Exrate			-0.068	-0.09	0.051		-0.099	-0.053	
			[0.018]***	[0.018]***	[0.035]		[0.022]***	[0.010]***	
PPI Inflation in all Trade			0.017	-0.017		-0.001	-0.003		0.002
Partners (import-weighted median)			[0.008]**	[0.008]**		[0.012]	[0.012]		[0.008]
Ch. Commodity Prices (GSCI)			0.002	0.025		0.001	-0.004		0.011
			[0.004]	[0.005]***		[0.010]	[0.013]		[0.004]***
				Information on First Stage (Instrument is Change of Ln(USD/RMB) and Instrumented Variable is ch. IPI Filtered)					
P Value associated with Kleibergen-Paap rk Wald F statistic						0.001<	0.001<		0.001<
Max rej. Stock-Yogo Max IV Size Level						10%	10%		10%
Observations	30729	25276	30729	20867	5712	20867	20867	30729	20867
Number of Groups	411	418	411	417	113	417	417	411	417
R-squared (OLS)	0.01	0.16	0.01	0.19	0.18	-	-	0.01	-

Notes: Table 2 presents the results of fixed effect panel estimations (OLS or 2SLS) relating US import prices to US producer prices. All changes refer to cumulated 3-months changes and all specifications include seasonality dummies (monthly). In (1), (3), and (8 A), the sample covers the period from January 1995 to June 2005 and in all other specifications, the sample covers the period from July 2005 to March 2011. In (1)-(8 A), the dependent variable is the change in the sectoral US PPI, while in (8 B), the dependent variable is the "Filtered PPI", equivalent to the residual of the out-of-sample prediction of the model estimated in (8 A) (see main text). The variables change in USD/ROW exchange rate is calculated on a trade-weighted basis using one year lagged import shares (all imports except China) as weights. The variable PPI Inflation in trade partners is calculated using the same weights within all US trade partners; the dependent variable "Filtered IPI" in (5), 7), and (8 B) is equivalent to the residual of the out-of-sample prediction of the model estimated in (6) of Table 1 (see main text); All standard errors are clustered by underlying import price index availability (i.e. by 5-digit sectors) and denoted in brackets below the coefficients; * denotes significant at 10%; ** significant at 5%, *** significant at 1%.

Table 3 - Robustness of Pass-Through of RMB and other Exchange Rates into US Prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	not controlling for	*only contr. For PPI*	*controlling for:*		*not contr. For*	*AR Terms*	*alt. matching*	*analysis at*
	PPI inflation abroad	*inflation in China*	*Cap. Utilization*	*Energy & Com.*	*Commodities*	*(1 Year)*	*any NAICS 6D*	*5-Digit Level*
Panel B: Second Stage Estimation - Dependent Variable is the change in the sectoral US PPI								
Ch. US IPI (Instrumented)	**0.71**	**0.719**	**0.718**	**0.638**	**0.849**	**0.516**	**0.683**	**1.032**
	[0.077]***	**[0.079]*****	**[0.070]*****	**[0.081]*****	**[0.043]*****	**[0.062]*****	**[0.085]*****	**[0.292]*****
PPI Inflation in all Trade			0.003	-0.001	0.015	-0.006	0.002	-0.013
Partners (import-weighted median)			[0.007]	[0.007]	[0.007]**	[0.007]	[0.008]	[0.020]
PPI Inflation China		0.004						
		[0.002]**						
Ch. Capacity Utilization			0.004					
			[0.008]					
Ch. All Commodity Prices (GSCI)	0.011	0.01	0.01	0.005		0.02	0.012	-0.012
	[0.003]***	[0.004]***	[0.003]***	[0.005]		[0.003]***	[0.005]**	[0.014]
Ch. Energy Commodity Prices (GSCI)				0.009				
				[0.002]***				
Ch. Metal Prices (GSCI)				-0.005				
				[0.004]				
6M Lag of IPI Price						0.053		
						[0.008]***		
12M Lag of IPI Price						-0.008		
						[0.012]		
Panel A: First Stage Estimation - Post 2005 Subsample - Dependent Variable is the change in the sectoral US Import PI								
Ch. USD/RMB	0.335	0.324	0.389	0.338	0.658	0.274	0.567	0.292
	[0.045]***	[0.045]***	[0.045]***	[0.048]***	[0.039]***	[0.044]***	[0.047]***	[0.083]***
PPI Inflation in all Trade			0.002	0.001	0.046	0.002	-0.011	-0.012
Partners (import-weighted median)			[0.010]	[0.010]	[0.010]***	[0.010]	[0.011]	[0.019]
PPI Inflation China		-0.012						
		[0.003]***						
Ch. Capacity Utilization			0.082					
			[0.010]***					
Ch. All Commodity Prices (GSCI)	0.041	0.043	0.03	0.049		0.039	0.055	0.037
	[0.003]***	[0.003]***	[0.003]***	[0.004]***		[0.003]***	[0.003]***	[0.005]***
Ch. Energy Commodity Prices (GSCI)				-0.007				
				[0.004]*				
Ch. Metal Prices (GSCI)				-0.005				
				[0.007]				
6M Lag of IPI Price						0.038		
						[0.007]***		
12M Lag of IPI Price						-0.023		
						[0.009]**		
Weak Identification Tests								
P-value Assoc. w. Anderson canon. cor. LR statistic	0.001<	0.001<	0.001<	0.001<	0.001<	0.001<		0.001<
Max rej. Stock-Yogo Max IV Size Level	10%	10%	10%	10%	10%	10%		10%
Observations	21730	21730	21730	21730	21730	21685	26414	5877
Number of Groups	444	444	444	444	444	444	519	118
R-squared (1st Stage)	0.03	0.03	0.04	0.03	0.02	0.03	0.05	0.03

Standard errors in brackets; * significant at 5%; ** significant at 1%

Notes: Table 3 presents the results of two-stage least square panel estimations. Panel B presents results from the second stage relating instrumented US import prices to US producer prices. Panel A presents results from the first stage relating changes in the USD/RMB exchange rate to US import prices. In all specifications, changes refer to cumulated 3-months changes, seasonality dummies (monthly) are included, the sample covers the period from July 2005 to March 2011, and the depended variable is the change in the US PPI or IPI. Both PPI and IPI have been filtered (see main text). The variable USD/ROW exchange rate is calculated on a trade-weighted basis using one year lagged import shares (all imports except China) as weights. The variable PPI Inflation in trade partners is calculated using the same weights within all US trade partners. In (3), capacity utilization refers to the sectoral capacity utilization obtained from the "Survey of Plant Capacity Utilization" by the US Census. All commodity price indices are obtained from Goldman Sachs Commodity Indices (GSCI). (4) uses the energy and metal price sub-indices. Standard errors are denoted in brackets below the coefficients; * denotes significant at 10%; ** significant at 5%, *** significant at 1%.

Table 4 - Subsample Parameter Stability

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(1)-(3) adding time dummies			*(4)-(6) excluding sub-periods*			*Adding*
	pre Financial Crisis	*Oil Crisis Peak*	*Trade Collapse*	*pre Financial Crisis*	*Oil Crisis Peak*	*Trade Collapse*	*Trend*
Panel B: Second Stage Estimation - Dependent Variable is the change in the sectoral US PPI							
US IPI (Instrumented)	**0.727**	**0.653**	**0.711**	**0.824**	**0.613**	**0.563**	**0.699**
	[0.075]* **	**[0.211]*** **	**[0.077]*** **	**[0.064]*** **	**[0.112]*** **	**[0.073]*** **	**[0.081]*** **
PPI Inflation in all Trade	0.003	0.001	0.002	0.001	-0.007	0.003	0.003
Partners (import weighted median)	[0.008]	[0.009]	[0.008]	[0.013]	[0.008]	[0.006]	[0.008]
Commodity Prices	0.01	0.013	0.011	0.005	0.014	0.014	0.01
	[0.004]***	[0.007]*	[0.004]***	[0.004]	[0.005]***	[0.003]***	[0.004]***
Financial Crisis Dummy	-0.001						
	[0.001]						
Oil Price Peak Dummy		0.001					
		[0.002]					
Trade Collapse Dummy			0				
			[0.001]				
Trend (Year)							-0.001
							[0.000]**
Panel A: First Stage Estimation - Post 2005 Subsample - Dependent Variable is the change in the sectoral US Import PI							
USD/RMB	0.371	0.122	0.361	0.786	0.42	0.397	0.322
	[0.045]***	[0.059]**	[0.045]***	[0.085]***	[0.080]***	[0.038]***	[0.045]***
PPI Inflation in all Trade	0.003	0.014	-0.004	0.122	-0.004	0.051	0.003
Partners (import weighted median)	[0.010]	[0.011]	[0.010]	[0.022]***	[0.013]	[0.009]***	[0.010]
Commodity Prices	0.039	0.04	0.029	0.014	0.052	-0.005	0.039
	[0.003]***	[0.003]***	[0.004]***	[0.006]**	[0.003]***	[0.004]	[0.003]***
Financial Crisis Dummy	-0.004						
	[0.001]***						
Oil Price Peak Dummy		0.008					
		[0.001]***					
Trade Collapse Dummy			-0.008				
			[0.002]***				
Trend (Year)							-0.001
							[0.000]***
Weak Identification Tests							
P-value Assoc. w. Anderson canon. cor. LR statistic	0.001<	0.001<	0.001<	0.001<	0.001<	0.001<	0.001<
Max rej. Stock-Yogo Max IV Size Level	10%	10%	10%	10%	10%	10%	10%
Observations	20867	20867	20867	10646	16253	17476	21730
Number of Groups	417	417	417	395	417	417	444
R-squared (1st Stage)	0.03	0.03	0.03	0.05	0.03	0.01	0.03

Notes: Table 4 presents the results of two-stage least square estimates relating US import prices to US producer prices. All changes refer to cumulated 3-months changes and all specifications include seasonality dummies (monthly). In (1) to (3), the sample covers the period from July 2005 to March 2011, and the estimation includes a dummy that is equal to one during the financial crisis (after August 2007), during the oil price peak preceding the financial crisis (October 2007 to October 2008), or during the great trade collapse (August 2008 through April 2009), respectively. In (4) to (6), these three respective time periods (pre-financial crisis in (4), oil price peak in (5), and great trade collapse in (6)) are excluded from the regression. (7) adds a time trend. The variables change in USD/ROW exchange rate is calculated on a trade-weighted basis using one year lagged import shares (all imports except China) as weights. The variable PPI Inflation in trade partners is calculated using the same weights within all US trade partners; * denotes significant at 10%; **

Table 5 - Heterogeneous Pass-through Rates Across Sectors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Market Share China		*Demand Elasticity*		*Labor Intensity*		*Input Intensity*	
	Above Median	*Below Median*	*Above Median*	*Below Median*	*Above Median*	*Below Median*	*none*	*at least some*
	Panel A: ERPT into IPI - Dep. Var is Change in the US Import PPI							
Change USD/RMB	0.226	0.377	0.238	0.219	0.23	0.333	0.23	0.259
	[0.055]***	[0.169]**	[0.114]**	[0.103]**	[0.058]***	[0.124]***	[0.062]***	[0.137]*
	Panel B: PT of IPI into PPI - 2SLS Estimation - Dep. Var is the US PPI							
Change IPI	1.099	0.726	1.071	0.793	0.671	0.962	0.824	0.913
	[0.319]***	[0.182]***	[0.191]***	[0.177]***	[0.121]***	[0.151]***	[0.148]***	[0.154]***
	Sample Information (Panel A)							
No. Observations	4682	4951	8669	8491	7939	7749	7614	10508
No. Groups	94	95	168	169	154	155	147	213

Notes: Table 5 presents selected results from underlying two-stage least square panel estimations. Panel B presents results from the second stage relating instrumented US import prices to US producer prices. Panel A presents results from the first stage relating changes in the USD/RMB exchange rate to US import prices. In all specifications, changes refer to cumulated 3-months changes, seasonality dummies (monthly) are included, the sample covers the period from July 2005 to March 2011, and the depended variable is the change in the US PPI/IPI. The set of included controls includes the ROW exchange rate, global commodity prices, and trade-weighted PPI inflation abroad (coefficients not reported). For all estimations, the sample is split by a sector characteristic. In (1) and (2), the sample is split by the market share of Chinese importers, in (3) and (4) by demand elasticity, in (5) and (6) by the labor intensity of US production, and in (7) and (8) by input intensity. The main text and the appendix describes the construction of these sector characteristics. Standard errors are denoted in brackets below the coefficients; * denotes significant at 10%; ** significant at 5%, *** significant at 1%.