加快推进绿色低碳转型，建设中国特色生态文明

陈诗一[1*]　陈登科[2]

[1]安徽大学　复旦大学经济学院

[2]复旦大学经济学院

摘　要：党的十九大报告指出，要坚定不移地贯彻“创新、协调、绿色、开放、共享”的新发展理念。新发展理念吹响了新时代加快推进经济体系绿色低碳转型、建设中国特色生态文明的号角。作为建设现代化强国进程中一场广泛而深刻的经济社会变革，加快推进经济体系绿色低碳转型是贯彻新时代习近平生态文明思想的必然要求，体现了中国共产党不忘初心以人民为中心的发展理念，展现了中国在应对气候变化问题上的决心和雄心，彰显了中国坚持推动构建人类命运共同体大国责任与担当。推动科技创新实现绿色低碳关键前沿技术突破，优化资源配置实现经济协调发展，构建开放共享的新发展格局都是推动中国经济体系绿色低碳转型的重要方面。

关键词：习近平生态文明思想　新发展理念　绿色低碳转型　“双碳”目标

JEL 分类号：O20, Q50, Q54

刚刚过去的2021年，是党和国家历史上具有里程碑意义的一年。这一年，中国共产党迎来了成立100周年，从容应对百年变局和世纪疫情，团结带领全国各族人民持续不懈奋斗决胜全面建成小康社会，实现了第一个百年目标，开启了全面建设富强民主文明和谐社会主义现代化强国的新征程，向着第二个百年目标奋力前进。这一年也是“十四五”规划的开局之年。站在“两个一百年”奋斗目标历史交汇点，以习近平同志为核心的党中央科学把握当今中国和世界发展大势，坚定不移贯彻“创新、协调、绿色、开放、共享”的新发展理念，向世界庄严宣布，“中国将提高国家自主贡献力度，采取更加有力的政策和措施，二氧化碳排放力争于2030年前达到峰值，努力争取2060年前实现碳中和”[1]。加快推进中国经济体系绿色低碳转型，助力实现“双碳”战略目标是党和国家带领全国人民建设中国特色生态文明进程中的“大考”，是一场广泛而深刻的经济社会变革，事关中华民族永续发展，是贯彻新时代习近平生态文明思想的必然要求，体现了中国共产党不忘初心以人民为中心的发展理念，展现了中国在应对气候变化问题上的决心和雄心，彰显了中国坚持推动构建人类命运共同体大国责任与担当。

* 联系人：陈诗一，邮箱，shiyichen@fudan.edu.cn。

感谢国家自然科学基金创新研究群体项目（72121002）以及自然科学基金青年项目（71903033）的资助。

[1] 习近平，2020，《习近平在第七十五届联合国大会一般性辩论上发表重要讲话》，《人民日报》9月22日，第一版。

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved.　http://www.cnki.net

一、推进绿色低碳转型是贯彻新时代习近平生态文明思想的必然要求

党的十八大以来，习近平同志基于马克思辩证历史唯物主义立场，结合新时代中国特色社会主义建设伟大实践，对中国新时期“为什么建设生态文明，建设什么样的生态文明，怎样建设生态文明以及由谁来建设生态文明”等一系列重大理论和实践问题进行系统性阐述，形成了习近平生态文明思想。习近平生态文明思想是习近平新时代中国特色社会主义思想的重要组成部分，是马克思主义关于人与自然和谐共生关系中国化的最新成果，是指引中国新时代推进经济体系绿色低碳转型和生态文明建设的根本遵循和行动指南。改革开放以来，中国经济总体规模增长了近40倍，成为仅次于美国的世界第二大经济体。中国的人均GDP也从改革开放初期的300美元左右增长到目前的超过1万美元，增幅超过30倍，正处于向世界中高收入国家迈进的重要关口。与此同时，中国也付出了较为沉重的生态环境代价。加快推进经济体系绿色低碳转型、建设新时代中国特色生态文明势在必行。

传统经济发展思维通常将经济发展与绿色低碳转型甚至与生态文明建设对立起来，认为实施环境保护、推进经济体系绿色低碳转型必将牺牲经济增长，甚至会导致经济增速跌到实现高质量发展的必要数值之下，尤其是考虑到我国以煤炭为主的资源禀赋特征（2020年，煤炭消费占中国能源消费的57%）。习近平同志基于“生态兴则文明兴，生态衰则文明衰”的深邃历史观，进一步提出“绿水青山就是金山银山”的绿色发展观，构成习近平生态文明思想的重要内容，为新时期中国实现绿色低碳转型与经济双赢发展奠定了理论基础、指明了前进方向。首先，随着人们生活水平的不断提高，对高质量生态环境的需求日益增加，随着人类发展，绿水青山及其自然服务逐渐变得稀缺（杨开忠，2021），与市场上的商品和服务类似，“绿水青山”本身越来越成为能够给人们带来效用的“产品”。从这个意义上来看，加快推进实现中国经济体系的绿色低碳转型能够通过改善生态环境直接带来经济效益。其次，现有实证研究广泛证实环境污染本身会对人们的身心健康造成损害（Greenstone and Hanna，2014；Zhang et al.，2018），从而降低劳动者生产过程中的效率（Chang et al.，2014）。陈诗一（2009）基于中国工业分行业数据实证考察了二氧化碳排放对经济增长的影响，其研究发现，对相当一部分工业行业而言，二氧化碳排放对经济增长的贡献显著为负。陈诗一和陈登科（2018）进一步基于中国地级市数据的实证研究发现，雾霾的主要污染源PM2.5每增加1微克/立方米，人均GDP（劳动生产率）下降100元左右，这意味着加快推进中国经济体系的绿色低碳转型、实现“双碳”战略目标能够通过提升劳动生产率来促进经济高质量发展。最后，加快推进中国经济体系的绿色低碳转型、实现“双碳”战略目标是一场广泛而深刻的经济社会系统性变革，可以说是对既有不符合新发展理念生产方式的“自我革命”，必将对中国未来经济社会发展的方方面面形成深刻影响。它会带来科技创新，促进产业结构转型升级，优化资源配置，有利于加快形成以国内大循环为主体、国内国际双循环相互促进的新发展格局。这些都是助推经济高质量发展的重要动力。

二、推进绿色低碳转型体现了中国共产党不忘初心以人民为中心的发展理念

中国共产党这个百年大党从诞生之日起就矢志不渝地将为中国人民谋幸福作为自己的初心和使命。党

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

的十九大报告指出，中国特色社会主义进入新时代，我国社会主要矛盾已经转化为人民日益增长的美好生活需要和不平衡不充分的发展之间的矛盾。人民对于美好生活的需要不仅体现在物质和精神上，还体现在生态环境上。习近平总书记强调，我们要建设的现代化是人与自然和谐共生的现代化，既要创造更多物质财富和精神财富以满足人民日益增长的美好生活需要，也要提供更多优质生态产品以满足人民日益增长的优美生态环境需要。加快推进经济体系绿色低碳转型核心要义之一就是要向人民提供优质的生态产品，体现了中国共产党为中国人民谋幸福的初心和以人民为中心的发展理念。十八大以来，为满足人民日益增长的优美生态环境需要、增进人民福祉，以习近平同志为核心的党中央顶层设计推出了一系列重大战略举措，推动中国经济体系绿色低碳转型、建设中国特色生态文明。

为应对日益严重的环境污染，中组部2013年对官员考核体系进行了结构性调整，明确提出弱化GDP增速的考核权重，同时加强生态环境保护等方面的考核。2015年5月，中共中央审议并通过《关于加快推进生态文明建设的意见》，对新时期中国生态文明建设和绿色低碳转型发展进行了全面部署，要求把绿色发展、循环发展、低碳发展作为生态文明建设的基本途径，将二氧化碳排放强度（单位GDP排放的二氧化碳量）作为约束性指标。2015年9月，中共中央、国务院印发《生态文明体制改革总体方案》，这是继《关于加快推进生态文明建设的意见》之后，党和国家在同一年内第二次对中国生态文明建设和绿色低碳转型发展进行顶层设计。《生态文明体制改革总体方案》的一项重要内容是，提出要完善生态文明绩效评价考核和责任追究制度，要求研究制定可操作、可视化的绿色发展指标体系，对领导干部实行自然资源资产离任审计，建立生态环境损害责任终身追究制。方案从政府和官员治理维度为推进中国经济低碳绿色转型提供了国家层面的制度性保障。中共中央2020年发布了《关于制定国民经济和社会发展第十四个五年规划和二〇三五年远景目标的建议》，这是中国未来经济社会发展相当长时期的纲领性文件，再次将加快推动绿色低碳发展放在突出位置，强调要降低碳排放强度，支持有条件的地方率先达到碳排放峰值，制定二〇三〇年前碳排放达峰行动方案。2021年，国务院进一步印发《关于加快建立健全绿色低碳循环发展经济体系的指导意见》，从健全绿色低碳循环发展的生产体系、健全绿色低碳循环发展的流通体系、健全绿色低碳循环发展的消费体系、健全绿色低碳循环发展的消费体系、构建市场导向的绿色技术创新体系以及完善法律法规政策体系等六大方面具体部署了推动经济体系低碳转型的工作。2021年7月全国碳市场正式上线交易，为实现绿色低碳转型发展注入了市场活力。

三、推进绿色低碳转型彰显了中国坚持推进人类命运共同体的大国责任与担当

以二氧化碳为主的人类温室气体排放大幅增加引起的全球气候变化，对人类经济社会发展与全球生态体系都构成了严重威胁。现有研究发现，如果无视全球气候变化，不从根本上改变高耗能、高排放与高污染的传统经济发展模式，那么到21世纪末，全球气温将至少升高2℃~3℃，这将导致全球GDP下降5%~10%，而贫穷国家GDP的降幅甚至超过10%（林伯强和蒋竺均，2009）。政府间气候变化专门委员会（Intergovernmental Panel on Climate Change，IPCC）报告研究显示，如果全球平均温度增幅超过 2.5℃，全球所有区域都可能遭受不利影响；如果全球平均温度增幅超过4℃，则可能对全球生态系统带来不可逆的损害，造成全球经济重

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

大损失，发展中国家所受损失将更为严重。除了对人类经济社会发展造成重大负面冲击之外，全球气候变化还可能造成生态灾难，引起极端天气频发，最终危及整个人类的生存。推进经济体系绿色低碳转型，建设中国特色生态文明是全球气候变化背景下人类可持续发展的必然选择（潘家华等，2010）。党的十九大报告指出，“中国共产党是为中国人民谋幸福的政党，也是为人类进步事业而奋斗的政党。中国共产党始终把为人类作出新的更大的贡献作为自己的使命”。气候变化是一个全球问题，事关人类命运共同体永续发展。推进经济体系低碳转型、发展建设生态文明彰显了中国坚持推进人类命运共同体的大国责任与担当。

（一）中国与世界其他主要国家二氧化碳排放历史与现状

考察中国与世界其他主要国家二氧化碳排放历史与现状，有助于我们深刻理解和全面把握中国这样一个发展中国家在应对气候变化、加快推进经济体系绿色低碳转型发展上的大国责任与担当。

首先来看二氧化碳年度总量排放。图1绘制了1850~2020年世界主要国家二氧化碳年度排放总量随时间变化的趋势。可以看出，在1850年以来的绝大多数历史时期中国二氧化碳排放量远低于其他世界主要国家。新中国成立以来，尤其是改革开放以来伴随着中国经济的增长，中国二氧化碳排放量也开始出现比较明显的上升。2001年加入世界贸易组织后，中国二氧化碳排放量甚至呈现出了加速上升态势，于2006年左右超越美国成为世界第一大二氧化碳排放国。2008年国际金融危机后，中国二氧化碳排放量出现了短暂下降之后又开始上升，但较于在此之前的10年，二氧化碳排放量增长速度出现了较大幅度的下降。2020年，中国的二氧化碳排放量为101亿吨，分别是排放量排名第二（美国）和排名第三（印度）的2倍和4倍。应该看到，在改革开放以来中国成为世界第一大二氧化碳排放国的过程中，消灭了绝对贫困，使得6.6亿人口成功脱贫，这本身就是对人类命运共同体建设的重大贡献。从图1中还可以看出的一个显著特征是，美国、日本、德国等世界主要发达国家基本都已出现峰值，而中国、印度、巴西等发展中国家的二氧化碳排放仍然处于增长阶段。目前，中国是世界第一大二氧化碳排放国，并且排放量尚未达峰，那么这是否一定意味着中国要承担全球二氧化碳减排的首要责任呢？我们的回答是否定的。这是因为，除了二氧化碳年度排放总量之外，划分国际碳减排责任需要考

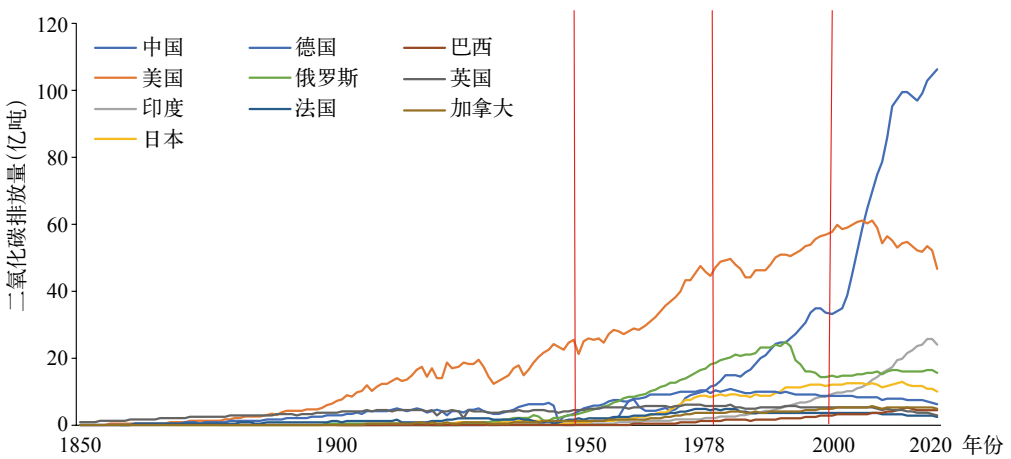

图1：1850~2020年世界主要国家二氧化碳年度排放量

数据来源：https://ourworldindata.org/。

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

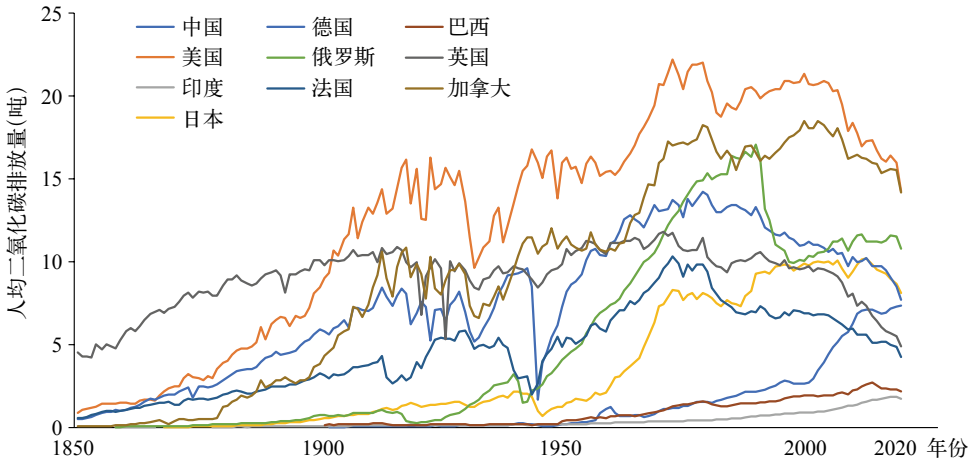

图2:1850~2020年世界主要国家人均二氧化碳排放量

数据来源:https://ourworldindata.org/。

虑人均二氧化碳排放量、历史累积二氧化碳排放量以及国际贸易隐含碳等更加重要的方面。

作为地球公民,每一个个体的发展都应得到尊重,都应得到平等的机会。因此,就二氧化碳排放而言,不应只看总量,还应(甚至更应)看人均。虽然从总量上看中国目前二氧化碳排放量位居世界第一,但是从人均上看中国二氧化碳排放量远低于美国等发达国家。图2绘制了1850~2020年世界主要国家人均二氧化碳年度排放量随时间变化的趋势。从图2中可以清楚地看到,与二氧化碳排放总量相同的是,在1850年以来的绝大数历史时期,中国人均二氧化碳年度排放量远远低于世界其他主要国家,与总量情形所不同的是,即便将时间拉至最近几年,中国的人均二氧化碳排放量也显著低于美国、加拿大等国。2020年,中国人均二氧化碳排放量为7.4吨,仅为美国和加拿大的1/2,与日本和德国的人均排放量相当。另外,值得注意的是,虽然进入21世纪初中国人均二氧化碳排放经历了一段快速增长期,但是党的十八大以来这种趋势明显减弱。

另外,主要温室气体二氧化碳在大气中有一定的寿命期,一旦排放到大气中,甚至可以存续数个世纪之久。发达国家经历了几百年的工业化,而中国的工业化历史只有几十年。工业革命以来,发达国家大量化石能源的燃烧是导致当前气候变暖的主要原因(樊纲等,2010)。因此,就二氧化碳排放而言,不应只看总量,还应(甚至更应)看历史。图3绘制了1850~2020年世界主要国家人均历史累积二氧化碳年度排放量随时间变化的趋势。从图中可以看出,中国人均历史累积二氧化碳排放量虽然高于印度和巴西这两个发展中国家,但是远远低于世界主要发达国家。1850~2020年的170年间,中国人均累积二氧化碳排放量只有189吨,甚至不到美国的1/10,是英国1/8、日本的1/3。以美国2020年人均二氧化碳排放量计算,中国170年所积累的人均二氧化碳排放量仅相当于美国13年所累积的量。

当今国际贸易的一个突出特征是,占据产业链顶端的发达国家通过国际分工将污染较为严重的产业放到环境规制相对较弱的发展中或落后国家(Copeland and Taylor,2004)。相当一部分国家因此而成为了"污染天堂"(Pollution Heaven)。现实中,一些国家(往往是发展中国家)在生产过程中排放了大量温室气体,然而这些国家所生产的产品中的相当一部分并不是用于本国消费,而是出口到其他国家(往往是发达国家)。因

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

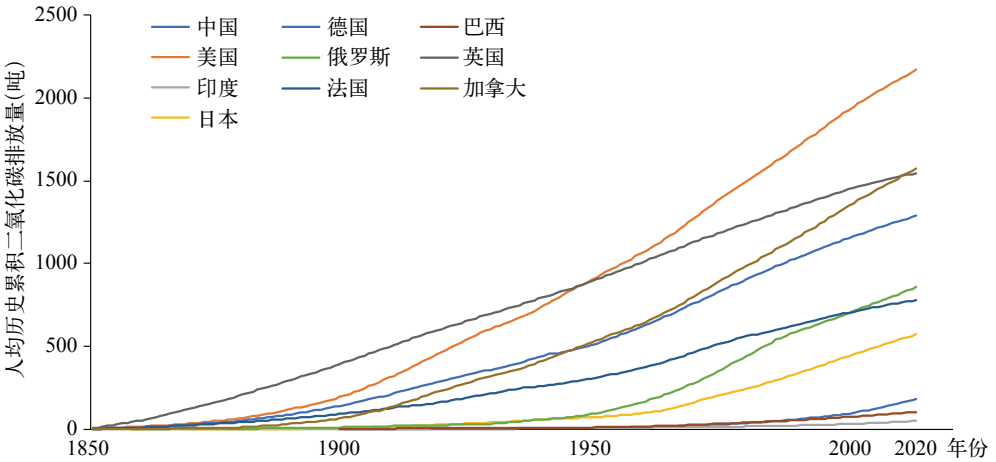

图3：1850~2020年世界主要国家人均历史累积二氧化碳排放量

数据来源：https://ourworldindata.org/。

此，就二氧化碳排放而言，不应只看生产，还应（甚至更应）看消费。根据“Our World in Data”网站所公布的数据，中国2000~2020年之间，净出口产品所隐含的二氧化碳量占其所生产产品二氧化碳排放量比重平均为14%，2006年这一数值甚至高达22%。这意味着，中国排放二氧化碳中的相当一部分是其他国家的消费所引致的。

综上，虽然从总量上看中国当前是世界上最大的二氧化碳排放国，但是从更加合理的人均和历史累积维度来看中国并不是造成当前国际气候问题的主要责任方。如果进一步从消费侧而非生产侧来看，中国对当前国际气候问题形成的责任则更小。

（二）应对气候变化实现全球绿色低碳发展的中国担当

根据上一节的介绍我们已经了解到，发达国家而非中国是造成当前国际气候问题的主要责任方。尽管如此，作为世界上最大的发展中国家，中国长期以来高度重视全球气候变化问题，始终坚持可持续发展战略，把绿色低碳发展作为生态文明建设的重要内容，主动承担国际气候变化责任，积极推动国际气候变化协作，为将大气温室气体浓度维持在一个稳定的水平并使人类活动对气候系统的危险干扰不会发生做出了重要贡献。1992年联合国大会根据“共同但有区别的责任”原则通过《联合国气候变化框架公约》，中国是该条约的最早缔约方之一。1998年中国又签署了旨在遏制全球气候变暖的《京都议定书》，这是人类历史上第一份具有法律约束力的气候协议。为配合《京都议定书》中相关要求，中国2007年出台《中国应对气候变化国家方案》，以此为主要标志，推进经济体系绿色低碳转型正式上升为国家战略。2009年中国向国际社会郑重承诺，到2020年单位国内生产总值二氧化碳排放比2005年下降40%~45%。

党的十八大以来，中国更是逐步从应对全球气候变化的主动参与者变为积极推动者和重要引领者。国内方面，为积极应对全球气候变化，统筹开展全国适应气候变化工作，2013年11月国家发改委、财政部等国务院9部委联合发布了《国家适应气候变化战略》，将应对气候变化相关措施制度化、体系化。区域方面，中国发布《关于推进绿色“一带一路”建设的指导意见》，助力沿线各国实现2030年可持续发展目标。国际方面，2015年

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

中国积极推动各国达成了《巴黎协定》，这是继《京都议定书》后又一份对签署国具有法律约束力的国际气候协议，代表了全球绿色低碳转型的大方向。2016年又率先签署《巴黎协定》，并积极推动落实其中的各项措施。2020年9月，习近平主席在第七十五届联合国大会一般性辩论上向世界庄严宣布，“中国将提高国家自主贡献力度，采取更加有力的政策和措施，二氧化碳排放力争于2030年前达到峰值，努力争取2060年前实现碳中和”。这意味着，作为世界上最大的发展中国家，中国将完成全球最高碳排放强度降幅，用全球历史上最短的时间实现从“碳达峰”到“碳中和”。2021年4月，习近平主席在领导人气候峰会上重申，中国以能源绿色低碳发展为关键，坚持走生态优先、绿色低碳发展的道路。2021年11月，习近平主席在向《联合国气候变化框架公约》第二十六次缔约方大会世界领导人峰会发表的书面致辞中进一步强调，中国秉持人与自然生命共同体理念，坚持走生态优先、绿色低碳发展道路，加快构建绿色低碳循环发展的经济体系。应该看到，以上措施均是在我国还是一个发展中国家且不是当前国际气候问题主要责任方的背景下做出的，彰显了应对气候变化实现全球绿色低碳发展的大国责任与担当。

四、深入贯彻新发展理念，加快推进经济体系绿色低碳转型

推进经济体系绿色低碳转型、建设生态文明如此重要，那么如何才能有效加快推进绿色低碳转型？党的十九大报告指出，发展是解决我国一切问题的基础和关键，发展必须是科学发展，必须坚定不移贯彻“创新、协调、绿色、开放、共享”的新发展理念。本节从新发展理念的几个维度来具体探讨加快推进经济体系绿色低碳转型的几个路径。

（一）推动科技创新，促进中国经济体系绿色低碳转型

创新位列新发展理念之首，居于国家发展全局的核心位置，是引领发展的第一动力。从根本上缓解经济发展与资源环境之间的矛盾、实现经济体系绿色低碳转型，需要推动绿色低碳科技创新，尤其需要在绿色低碳基础研究和前沿技术研发方面取得突破。事实上，改革开放以来，技术进步所带来的生产效率提升大大提升了中国绿色低碳发展水平。如果简单地利用单位GDP二氧化碳排放量（二氧化排放碳强度）来度量绿色低碳技术进步（单位GDP二氧化碳排放量越高，绿色低碳技术水平越低，反之则相反），那么从图4中能够看到，改革开放以来，中国单位GDP二氧化碳排放量大幅下降，从1978年的40.58吨/万元一路下降到2020年的1.05吨/万元，下降幅度高达97%。我们知道，中国政府2009年向国际社会郑重承诺，到2020年单位国内生产总值二氧化碳排放比2005年下降40%~45%。从实际数据来看，2005年中国单位GDP二氧化碳排放量为3.14吨/万元，2020年的数值是1.05吨/万元。与2005年相比，中国2020年单位GDP二氧化碳排放量实际下降了67%，远远高于2009年的承诺值，再次彰显了中国在应对全球气候变化问题上的大国责任与担当。

改革开放以来，中国在绿色低碳技术进步上已经取得了非常可喜的成绩。站在全面建设社会主义现代化强国的新方位，面对深刻变化的国际国内形势，中国继续推绿色低碳技术创新，需要在以下几个方面发力：第一，与其它关键领域核心技术类似，绿色低碳核心技术“买不来、等不来”，需要瞄准绿色低碳技术前沿，健全绿色低碳基础研究支撑体系，提升绿色低碳核心技术的自主创新能力，补齐我国绿色低碳科技基础薄弱的短

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

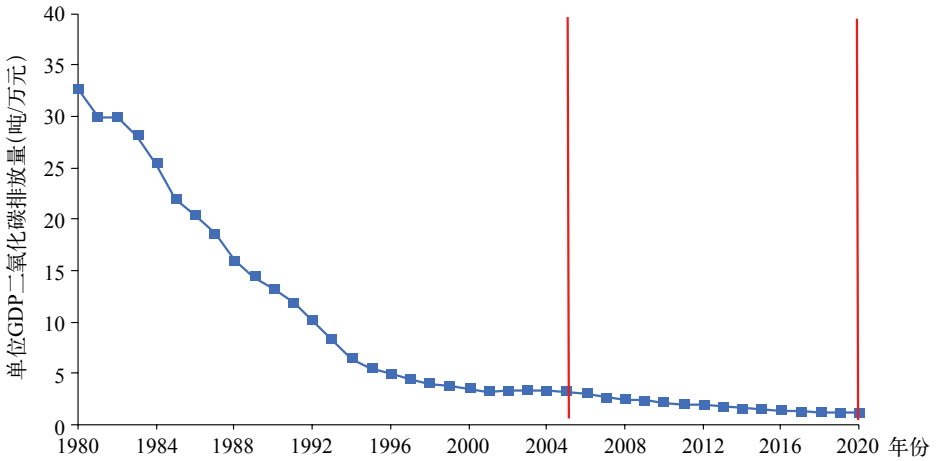

图4:1978~2020年中国单位GDP二氧化碳排放量(二氧化碳排放强度)

数据来源:《中国统计年鉴》。

板,避免受制于人。绿色低碳核心技术不仅能够通过提升现有经济产业的效率来推动经济体系绿色低碳发展,而且往往还能够催生一系列绿色战略新兴产业,这也有助于经济体系的绿色低碳转型。第二,市场是检验绿色低碳技术价值的最终"试金石",需要充分发挥市场对绿色产业发展方向和技术路线选择的决定性作用,强化企业技术创新主体地位,充分调动市场机制配置绿色低碳科技创新资源。第三,科技创新尤其是关键领域核心技术创新研究通常具有"投资大,风险高,周期长,外溢强"的特点,绿色低碳核心技术创新也不例外。正是因为如此,市场主体特别是单个企业通常不具有足够的经济激励去开展绿色低碳技术创新。因此,推动绿色低碳核心技术创新还需要充分发挥政府的引导和支持作用,建立符合生态文明建设领域科研活动特点的管理制度和运行机制。

(二)优化资源配置,推动中国经济体系绿色低碳转型

优化资源配置也是推动经济体系绿色低碳转型重要方面,对应新发展理念中的"协调发展"维度。科技创新通过推动技术前沿进步来促进经济体系绿色低碳转型,而优化资源配置可以在不改变技术前沿的条件下推动经济体系绿色低碳转型。其基本逻辑在于,宏观经济效率是不同生产主体效率的加权平均,而生产主体间的效率通常存在着客观的差异,因此将生产要素从低效率的生产主体重新配置到高效率生产主体,能够在不增加要素投入甚至是不改变生产主体技术前沿的前提下,提升宏观经济效率,从而推动经济体系绿色低碳转型。虽然改革开放以来中国资源配置效率有了显著提升,然而中国经济当前发展过程中依然存在较大的扭曲(陈诗一、陈登科,2017)。Hsieh 和 Klenow(2009)这篇具有影响力的研究显示,资源配置扭曲导致中国经济运行效率降低了30%~50%。换言之,给定要素投入与技术前沿不变,优化资源配置本身能够使得中国宏观经济效率提升30%~50%,从而显著降低污染排放,推动经济体系绿色低碳转型。

优化资源配置本质上是经济发展结构的优化,它涉及到诸多维度。在这里,我们从产业结构优化和能源结构优化这两个方面来介绍。首先来看产业结构优化。图5给出了1978~2020年中国三大产业占比的趋势图,

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

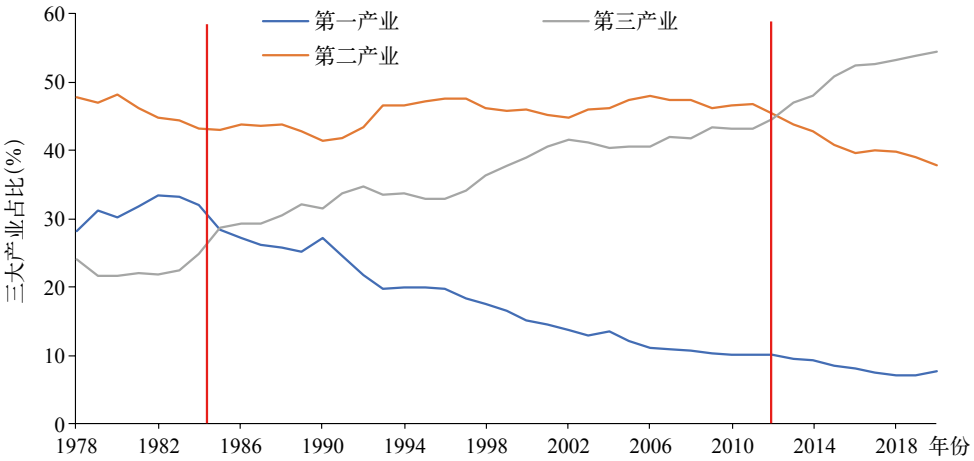

图5：1978～2020年中国国民经济产业结构变迁

数据来源：《中国统计年鉴》。

该图反映了经济资源在国民经济三大产业间的重新配置。从图形中可以看出，改革开放以来，第一产业在国民经济中的比重持续下降，从改革开放初期的30%左右下降到2020年的7%左右，与此相对应，第三产业在国民经济中的比重持续上升，从改革开放初期的20%左右一路上升到了2020年的55%。第二产业占比稳中有降，基本维持在40%～50%之间，党的十八大以来呈现出了较为明显的下降趋势。一般而言，第二产业单位GDP能耗显著高于第三产业。从这个意义上来看，第二产业占比的下降和第三产业占比的上升（即将资源由第二产业向第三产业配置）有助于降低污染物排放，为推动经济绿色低碳发展做出了贡献。尽管如此，我们认为，新时期的绿色低碳转型应由产业间资源配置驱动为主转变为产业内部驱动为主。究其原因在于，中国第二产业占比目前已经下降到了40%以下，而建设社会主义现代化强国必须要有以实体经济为主的第二产业，特别是高端制造业作为重要支撑，第二产业占比继续下降的空间已经很小。也就是说，对于绿色低碳转型发展而言，未来更重要的是，通过淘汰落后产能将资源配置到同一产业中效率更高的经济单位，实现产业优化升级。

再来看能源结构优化，这涉及的是能源要素本身的配置。图6绘制了1978～2020年中国能源消耗与能源结构趋势图。从图形中可以看出，伴随着中国能源消费量的快速上升，中国能源结构也发生了显著变化。煤炭占能源消耗总量的比重由改革开放初期的70%左右下降到2020年的56%，下降幅度达到1/5。原油、天然气等其他能源的占比相应地从改革开放初期的30%左右上升到2020年的44%。煤炭消耗是温室气体和环境污染物排放的主要贡献者。因此，改革开放以来的能源结构变化降低了中国温室气体和环境污染物排放。降低煤炭消耗占比有助于推动经济绿色低碳转型，但是这并不必然意味着新时期中国应该继续通过大幅降低煤炭消耗占比来推动经济体系低碳转型。主要原因在于，继续大幅降低煤炭消耗占比不符合中国以煤炭为主的资源禀赋特征。此外，从能源安全的角度来看，作为一个拥有14亿人口的世界上最大发展中国家，中国的能源消耗不可能也不应该主要依赖进口。这意味着大力发展煤炭清洁技术是缓解中国资源禀赋与绿色低碳发展矛盾的重要手段。即便将来煤炭消耗占比有所降低也应该是内生于产业结构的优化升级。比如，经济从以低端制造业为主到以高端制造业为主转型的过程中，煤炭需求本身会随之下降，煤炭消耗占比自然会相应降低。

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

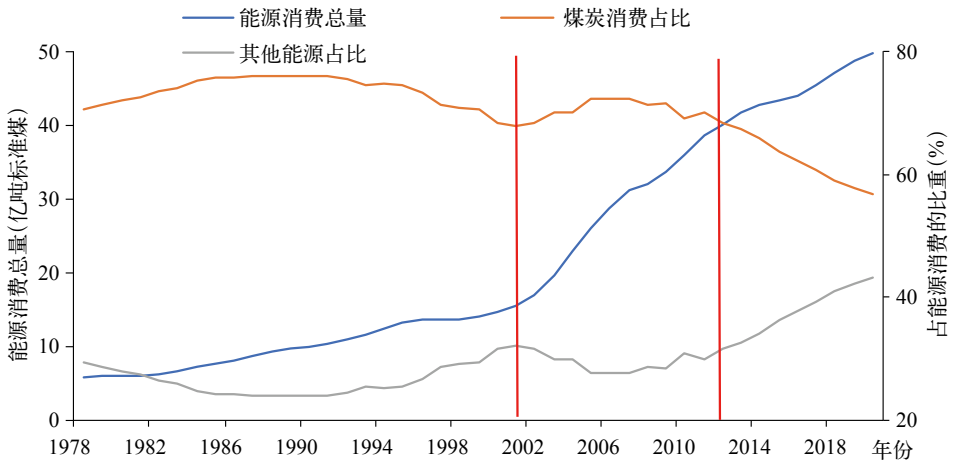

图6:1978~2020年中国能源消费量与结构

数据来源:《中国统计年鉴》。

(三)构建开放共享的新发展格局,深化经济体系绿色低碳转型

开放与共享是发展理念的两个重要维度,对于推动经济体系绿色低碳转型发展具有重要意义。首先来看"开放"维度。改革开放尤其是党的十大八大以来,中国在绿色低碳领域技术上取得了一系列的重要突破。但是应该充分认识到,在绿色低碳领域关键前沿技术上,中国与发达国家还存在一定的差距。因此,中国推动经济体系绿色低碳转型绝不是关起门来自己搞,而应是在构建"国内大循环为主体、国内国际双循环相互促进的新发展格局"的基础上在更高层次扩大开放,充分借鉴吸收发达国家技术、理念和经验,以此来最终服务于我们绿色低碳前沿技术的自主创新。其次来看"共享"维度。对于推动经济体系绿色低碳转型,共享发展理念的一个重要内容是,培育低碳绿色生活方式,反对铺张浪费,大力发展循环经济。

参考文献

[1] 陈诗一,2009,《能源消耗、二氧化碳排放与中国工业的可持续发展》,《经济研究》第4期。

[2] 陈诗一、陈登科,2017,《中国资源配置效率动态演化——纳入能源要素的新视角》,《中国社会科学》第4期。

[3] 陈诗一、陈登科,2018,《雾霾污染、政府治理与经济高质量发展》,《经济研究》第2期。

[4] 樊纲、苏铭、曹静,2010,《最终消费与碳减排责任的经济学分析》,《经济研究》第1期。

[5] 林伯强、蒋竺均,2009,《中国二氧化碳的环境库兹涅茨曲线预测及影响因素分析》,《管理世界》第4期。

[6] 潘家华、庄贵阳、郑艳、朱守先、谢倩漪,2010,《低碳经济的概念辨识及核心要素分析》,《国际经济评论》第4期。

[7] 杨开忠,2021,《习近平生态文明思想实践模式》,《城市与环境研究》第1期。

[8] Chang, Tom, Joshua Graff Zivin, Tal Gross, Matthew Neidell. 2016. "Particulate Pollution and The Productivity of Pear Packers." *American Economic Journal: Economic Policy*, 8(3): 141-69.

[9] Copeland, Brian, Scott Taylor. 2004. "Trade, Growth, and the Environment." *Journal of Economic literature*, 42(1): 7-71.

[10] Hsieh, Chang-Tai, Peter J. Klenow 2009. "Misallocation and Manufacturing TFP in China and India." *The Quarterly Journal of Economics*, 124(4) : 1403-1448.

[11] Greenstone, Michael, Rema Hanna 2014. "Environmental Regulations, Air and Water Pollution, and Infant Mortality in India." *American Economic Review*, 104(10) : 3038-72.

[12] Zhang, Xin, Chen Xi, Zhang Xiaobo. 2018. "The Impact of Exposure to Air Pollution on Cognitive Performance." *Proceedings of the National Academy of Sciences*, 115(37) : 9193-9197.

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

On Accelerating the Green and Low-Carbon Transition for an Ecological Civilization with Chinese Characteristics

Chen Shiyi[1*] and Chen Dengke[2]
[1] *Anhui University, Hefei, China*
[1,2] *School of Economics, Fudan University, Shanghai, China*

Abstract: *The Report to the 19th National Congress of the Communist Party of China (CPC)called for steadfastly implementing the new philosophy of "innovative, coordinated, green, open, and shared" development, for expediting China's green and low-carbon economic transition, and for developing a so-called "ecological civilization with Chinese characteristics." As an extensive and profound socio-economic transformation in building a strong, modern nation, the green and low-carbon transition is viewed as an essential requirement for creating an ecological civilization in line with Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era. The transition reflects the commitment of the CPC to its original aspirations to increase the welfare of the people and the principle of putting the people first as well as China's resolve and ambition to confront climate change issues.*

Keywords: *Ecological civilization, new development philosophy, green and low-carbon transition, carbon peak, carbon neutrality*
JEL Classification Code: O20, Q50, Q54
DOI: 10.19602/j.chinaeconomist.2022.03.02

The year 2021 marked of the 100th anniversary of the founding of the Communist Party of China (CPC) and also marked the beginning of China's 14th Five-year Plan period. Presently, the CPC Central Committee has set a goal to implement the new philosophy of "innovative, coordinated, green, open, and shared" development and has declared that "China will scale up [its] intended, nationally determined contributions to decrease the global warm gas emission and enact more vigorous policies and measures that aim to have carbon dioxide emissions peak before 2030 and to achieve carbon neutrality before 2060."[1] In leading the whole nation toward an "ecological civilization with Chinese characteristics," the CPC faces a big test in the form of carrying out the proposed greening of China's economy and achieving its carbon peak and carbon neutrality goals. As an extensive and profound socio-economic transformation deemed vital to the sustained development of the Chinese nation, the green and low-carbon transition is an explicit requirement of implementing General Secretary Xi Jinping's "Thought on Ecological Civilization for a New Era" and manifests the CPC's commitment to its original aspirations to increase the welfare of the people and development philosophy of putting the people first, as well as the nation's resolve and ambition to confront climate change issues.

* CONTACT: Chen Shiyi, email: shiyichen@fudan.edu.cn.
Acknowledgement: Science Fund for Creative Research Groups of the National Natural Science Foundation of China (Grant No. 72121002), National Natural Science Foundation of China (Grant No. 71903033).
[1] Statement by Xi Jinping at the General Debate of the 75th Session of The United Nations General Assembly, 2020.

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

1. China's Green and Low-Carbon Transition: An Explicit Requirement of Implementing Xi Jinping's "Thought on Ecological Civilization for a New Era"

Since the 18th CPC National Congress, General Secretary Xi Jinping has systematically elaborated a series of theoretical and practical issues on "why ecological civilization matters, what type of ecological civilization should be pursued, and how and who should build an ecological civilization" that form what have become known as Xi Jinping's "Thought on Ecological Civilization." As a key component of Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era and the latest result of the sinicization of Marxist theory on the symbiosis between mankind and nature, his thought on ecological civilization has become fundamental guidance for China to advance the green and low-carbon transition of its economic system and build an ecological civilization for a new era. Since the economic reform policies enacted in 1978, China has seen its economy grow by close to 40 times to become the world's second-largest economy after the United States. China's annual GDP per capita has also grown by over 30 times from around 300 US dollars at the inception of the reforms to approximately 10,000 US dollars, a key stepping stone towards becoming an upper-middle-income country. However, China has paid a heavy price in terms of environmental damage in order to accomplish this, which underscores the urgency to transition to a green and low-carbon economy.

Traditional Chinese concepts of economic development have often antagonized economic development with a green and low-carbon transition or even an ecological civilization, believing the latter would come at the expense of curtailing China's economic growth to a sub-optimal level, especially in light of China's coal-dominated natural resource endowment (in 2020, coal consumption accounted for 57% of all energy production). Based on his notion that "a civilization may thrive if its natural surroundings thrive, and will suffer if its natural surroundings suffer," General Secretary Xi further put forth his concept of green development that "lucid waters and lush mountains are invaluable assets" that now forms the theoretical basis for China's green and low-carbon transition and guides the direction for future economic development.

With rising living standards, people crave for a better ecological environment, and "lucid waters" and "lush mountains" would become scarce amid economic development (Yang, 2021). Similar to goods and services available in the market, lucid waters and lush mountains are also goods that bring utility to people. In this sense, green and low-carbon transition can create economic benefits by improving the ecological environment and increasing the level of these types of goods that people can enjoy. Moreover, existing empirical studies have shown that physical and psychological damage of environmental pollution (Greenstone and Hanna, 2014; Zhang et al., 2018) can impair workers' efficiency (Chang et al., 2014). Based on China's industrial sector data, Chen (2009) found that CO_2 emissions contributed negatively to economic growth for a considerable portion of industrial sectors, and based on empirical research on data from China's prefectural cities, Chen and Chen (2018) further found that an increase in the smog-inducing PM2.5 concentration by one microgram/m^3 caused annual GDP per capita to fall by about 100 yuan. Hence, by greening its economy, China stands not only to benefit its people and ecological environment but also to increase its economic output. This proposed extensive socio-economic transformation may revolutionize the existing modes of production that are inconsistent with the "new development philosophy" and transform every aspect of China's socio-economic development. Such a transition may induce technological innovation, propel industrial upgrades, and optimize resource allocation, giving rise to a new development paradigm.

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

2. China's Green and Low-Carbon Transition Reflects the CPC's Commitment to Its Original Aspirations and People-Centered Development

As noted in the Report to the 19th CPC National Congress, in the new development era of socialism with Chinese characteristics, China's primary social contradiction between the growing material and cultural needs of the people and the backward social production has evolved into one between unbalanced and inadequate development and its people's ever-growing demands for a better life. People's desire for a better life is manifested not only in material and cultural aspects but in yearning for a beautiful environment as well. Indeed, General Secretary Xi has stressed that China should pursue modernization in which people live in harmony with nature, and a key aspect of China's green and low-carbon transition is to provide its people with desirable ecological goods. Since the 18th CPC National Congress, the CPC Central Committee with Xi at the core has already enacted a series of strategic initiatives to green China's economy and to build ecological civilization with Chinese characteristics.

For example, in order to cope with extensive pollution, the Organization Department of the CPC Central Committee restructured its performance evaluation system for government officials, prioritizing environmental protection over GDP growth. In May 2015, the CPC Central Committee adopted its *Opinions on Accelerating the Development of Ecological Civilization*, which called for all-round arrangements on China's ecological civilization and green and low-carbon development in the new development era. The *Opinions* identified green, circular, and low-carbon development as the basic pathway toward an ecological civilization and put forth targets on CO_2 emissions intensity (CO_2 emissions per unit of GDP). In September 2015, the CPC Central Committee and the State Council released their *Master Plan for Institutional Reform Towards Ecological Civilization* (*Master Plan*), which is the second top-down design document issued by the Party and the State in the same year related to China's ecological civilization and green and low-carbon transition. The *Master Plan* called for improving the performance evaluation and accountability systems for ecological civilization, for adopting practical green development indicators, and for implementing off-office auditing of natural resource assets for government officials in leadership positions, as well as governments and officials' lifelong environmental accountability system. From the dimension of government accountability, the *Master Plan* offers national-level institutional guidance for China's green and low-carbon transition.

In 2020, the CPC Central Committee released its *Proposal on the 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035*. This document gives prominence to accelerating green and low-carbon development and calls for reducing carbon intensity, supporting localities with appropriate conditions to take the lead to peak their carbon emissions, and formulating an action plan for achieving carbon peak by 2030. In 2021, the State Council released its *Guiding Opinions on Establishing a Sound Economic System for Green and Low-Carbon Circular Development*, which made specific arrangements on the low-carbon transition of China's economic system in the six aspects of production, distribution, and consumption systems for green and low-carbon circular development, the green upgrade of infrastructure, a market-based green technology innovation system, and an improved legal and regulatory system. As a result of this, the launch of China's national emissions trading scheme (ETS) in July 2021 was a first step in China's green and low-carbon transition.

3. The Role of China's Green and Low-Carbon Transition in the Global Economy

Global climate change induced by a spike in man-made greenhouse gas emissions, primarily CO_2 emissions, poses a serious threat to worldwide socio-economic development and the entire global ecosystem (IPCC). Lin and Jiang (2009) argue that short of actions to reverse the energy-intensive and

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

pollution-heavy modes of economic development, global temperature may rise by 2°C to 3°C by the end of this century, which may cause global GDP to fall by 5% to 10% and GDP in poor countries in particular to decrease by over 10%. According to a research report by the Intergovernmental Panel on Climate Change (IPCC), an increase in global mean temperature by 2.5°C may cause negative effects in all regions of the world and an increase in global mean temperature by over 4°C may irreversibly damage the global ecosystem and wreak havoc on the global economy, especially in the developing world. Aside from possibly upending mankind's socio-economic development, climate change may also lead to ecological catastrophes and increase the frequency of extreme weather events. Advancing the green and low-carbon transition of the China's economic system and building an ecological civilization with Chinese characteristics have become a natural choice for sustainable development in China in the context of climate change (Pan et al., 2010). As noted in the Report to the 19th CPC National Congress, "The CPC is a political party that seeks happiness for the people and progress for humanity. The CPC always takes [it] upon itself to make new and greater contributions to humanity."

3.1 Past and Present Levels of CO_2 Emissions from China and Other Major Countries

A review of the past and present level of CO_2 emissions from China and other major countries can help to frame China's strategy for coping with climate change and greening its economy. First, we discuss annual total CO_2 emissions. Figure 1 shows the temporal trend of annual total CO_2 emissions from major countries from 1850 to 2020. Here we see that China's CO_2 emissions have been dwarfed by other major countries for most of the time since 1850 until their relatively rapid rise that began in 1978. Since the founding of the People's Republic of China in 1949 and especially reform and opening up in 1978, China's CO_2 emissions have spiked with economic growth. Following its WTO entry in 2001, China's CO_2 emissions have been increasing at an accelerating pace, replacing the United States as the world's largest CO_2 emitter ever since 2006. After the global financial crisis of 2008, China's CO_2 emissions briefly decreased before rising again at a much slower pace compared with the previous decade. In 2020, China's CO_2 emissions stood at 10.1 billion tons, which were two and four times those of the United States (the second largest emitter) and India (the third largest emitter), respectively. On the path to becoming the world's largest CO_2 emitter ever since 1978, China also dramatically reduced absolute poverty, lifted 660 million people out of poverty over this time period. Another salient fact that can be seen from Figure 1 is that while CO_2 emissions appear to have peaked in major developed countries like the United States, Japan, and Germany, CO_2 emissions in developing countries like China,

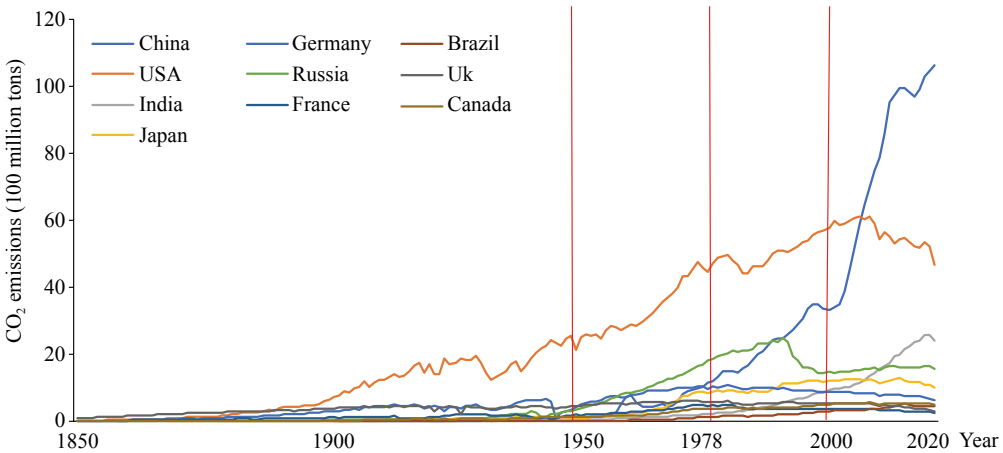

Figure 1: Annual CO2 Emissions of Major Countries from 1850 to 2020

Source: https://ourworldindata.org/.

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

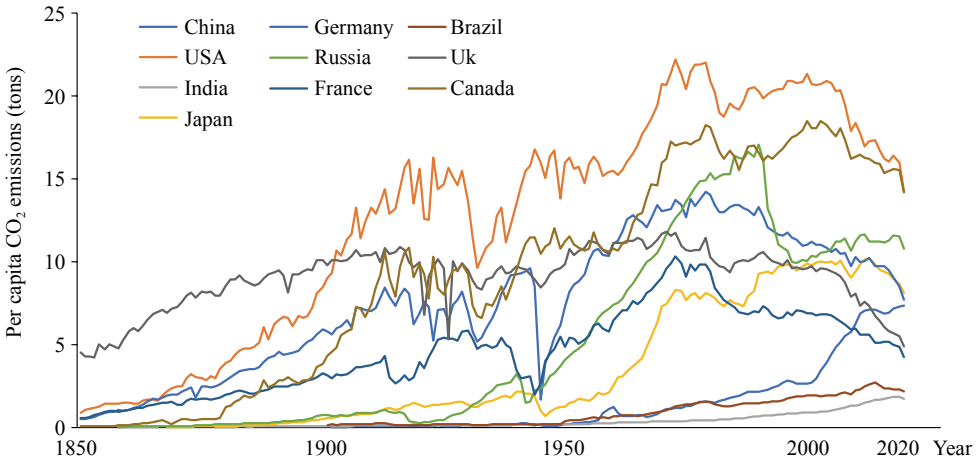

Figure 2: Annual Per Capita Carbon Emissions of Major Countries from 1850 to 2020

Source: https://ourworldindata.org/.

India, and Brazil have continued to grow. For China as the world's largest CO_2 emitter with emissions yet to peak, the question is whether China should assume the primary responsibility for global CO_2 emissions reduction? Our answer is no, and the reason is that apart from annual total CO_2 emissions, we believe that there are other, more important dimensions to the problem of CO_2 emissions such as CO_2 emissions on a per capita and historical cumulative basis and emissions embodied in trade, in dividing international responsibilities for reducing carbon emissions.

We believe that per capita emissions are equally, if not more, important as aggregate emissions. Although China has become the world's largest CO_2 emitter, it is far behind developed countries like the United States on a per capita level. Figure 2 shows the temporal trend of per capita CO_2 emissions from 1850 to 2020. Here we see that, China's per capita annual CO_2 emissions have been far smaller compared with other major countries for most of the time since 1850. Unlike the aggregate volume of CO_2, China's per capita CO_2 emissions have been significantly smaller compared with countries like the United States and Canada even in recent years as well. In 2020, China's annual per capita CO_2 emissions stood at 7.4 tons per person, which was only half the level of the United States and Canada and equivalent to those of Japan and Germany. Despite a period of rapid increase in China's per capita CO_2 emissions at the dawn of the 21st century, this trend has significantly diminished since the 18th CPC National Congress held in 2012.

As a major greenhouse gas, CO_2 can stay in the atmosphere several centuries. While developed countries have experienced centuries of industrialization, China's industrial development started just a few decades ago. Ever since the Industrial Revolution, hydrocarbon combustion in the developed world has been the key cause of today's global warming (Fan et al., 2010). Therefore, we believe that one should look not only at aggregate volume but also, historical emissions. Figure 3 shows the temporal trend of historical cumulative annual per capita CO_2 emissions from 1850 to 2020. From this we see that China's cumulative per capita CO_2 emissions are higher than those of India and Brazil, two other developing countries, but far below the levels of major developed countries. In the 270 years from 1850 to 2020, China's cumulative per capita CO_2 emissions only stood at 189 tons, which was less than one tenth that of the United States and equivalent to one eighth the level of the United Kingdom and one third the level of Japan.

Today's international trade is characterized by the relocation of polluting industries to developing or less developed countries with lax environmental regulation through international division of labor with more-developed countries at the top of industrial chains (Copeland and Taylor, 2004). Many

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

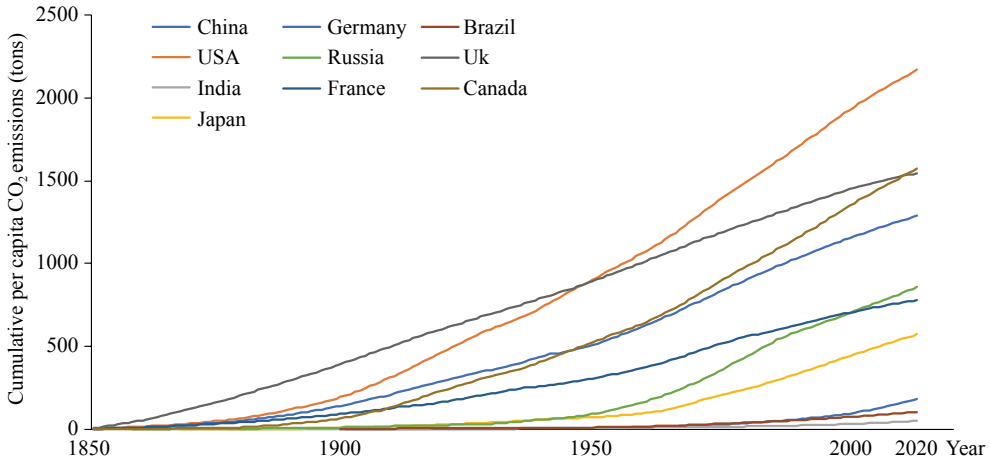

Figure 3: Cumulative Per Capita CO_2 Emissions of Major Countries from 1850 to 2020

Source: https://ourworldindata.org/.

countries have thus become reduced into "pollution havens." In reality, greenhouse gas emissions in some countries, usually developing ones, derive from the production of goods that are exported to other countries mostly in the developed world rather than those used in domestic consumption. Hence we believe that one should look not only at production but at consumption as well. According to data from the "Our World in Data" website, CO_2 emissions embodied in China's net exports accounted for an average of 14% of total CO_2 emissions from the manufacturing of all goods from 2000 to 2020. In 2006, this figure jumped to 22%. That is to say, a considerable portion of China's CO_2 emissions were induced by consumption demand in other countries. Based on the above analysis, although China is the world's largest CO_2 emitter, we believe that it is not primarily responsible for global climate woes when viewed from the dimensions of per capita and cumulative emissions, and even less responsible when further observed from the standpoint of international trade relationships.

3.2 China's Plans for Green and Low-Carbon Development

As the world's largest developing country, China has attached great importance to global climate issues, formulated a sustainable development strategy, identified green and low-carbon development as a key aspect of an ecological civilization, and sought improved cooperation on climate change. China has also made important contributions to keeping greenhouse gas concentration to a steady level and reducing the climate impact of human activity. For example, in 1992, the United Nations General Assembly adopted the United Nations Framework Convention on Climate Change (UNFCCC) based on the principle of "common but differentiated responsibilities," to which China is one of the earliest signatories, and in 1998, China signed the Kyoto Protocol aiming at containing global warming, which is the first-ever international climate agreement in human history. In line with the Kyoto Protocol requirements, China enacted its National Climate Change Program in 2007, which marks the elevation of the green and low-carbon transition of its economic system into a national strategy, and in 2009, China made a commitment to the international community to slash its CO_2 emissions per unit of GDP by 40% to 45% by 2020 from the level of 2005.

Since the 18th CPC National Congress in 2012, China has evolved from a mere participant in global climate change response to an active proponent and trailblazer. Domestically, China has carried out nationwide actions for climate change adaptation. In November 2013, China's National Development and Reform Commission (NDRC), the Ministry of Finance, and seven other ministerial agencies jointly released the *National Strategy for Climate Change Adaptation* to formalize China's climate change

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

adaptation initiatives, and regionally, China has released the *Guiding Opinions on Advancing the Belt and Road Initiative (BRI) Development* to assist BRI countries in achieving their 2030 sustainable development targets. Internationally, China began to play an active role in facilitating the Paris Agreement in 2015, another international climate deal after the Kyoto Protocol that represents the overwhelming trend of global green and low-carbon transition among many countries of the world.

Finally, in 2016, China signed the Paris agreement and made plans to implement the various measures contained therein.

In September 2020, President Xi Jinping declared to the world at the General Debate of the 75th Session of the United Nations General Assembly that "China will scale up its nationally determined contributions and adopt more vigorous policies and measures. We aim to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060." That is to say, China, as the world's largest developing country, aims to complete the world's highest carbon intensity reduction and transition from carbon peak to carbon neutrality in quite a short amount of time. In April 2021, President Xi reaffirmed at the Leaders Summit on Climate that China would embark upon a path of prioritizing ecological protection and green and low-carbon development, and in November 2021, he further stressed in his written speech at the World Leaders Summit at UNFCCC COP 26 that, "We will aim to achieve greener economic and social development in all aspects, with a special focus on developing green and low-carbon energy. We will continue to prioritize ecological conservation and pursue a green and low-carbon path to development."

4. The Implementation of New Development Concepts to Facilitate China's Green and Low-Carbon Economic Transition

Having explored the importance of green and low-carbon transition and ecological civilization, we now turn to the question of how to expedite the process effectively. As claimed in the Report to the 19th CPC National Congress, development holds the key to resolving all the problems that confront China. However, we believe that this development must be science-based and stick to the new philosophy of innovative, coordinated, green, open, and shared development. In this section, we discuss a few pathways for expediting the green and low-carbon transition of China's economic system under this philosophy.

4.1 The Promotion of Technological Innovation for China's Green and Low-Carbon Economic Transition

Technological innovation is the primary force for national development in China, and Green and low-carbon technological innovations in particular are essential in addressing resource and environmental constraints. In the post-reform era since 1978, China's CO_2 emissions per unit of GDP have decreased sharply, down 97% from 40.58 tons per 10,000 yuan of GDP in 1978 to 1.05 tons per 10,000 yuan in 2020, but China stated in 2009 that it intended to slash carbon intensity by 40% to 45% by 2020 from its 2005 level. However, China's CO_2 emissions per unit of GDP actually fell by 67%, far more than its intention made in 2009, from 3.14 tons per 10,000 yuan of GDP in 2005 to 1.05 tons per 10,000 yuan of GDP in 2020.

Since 1978, China has made many achievements in green and low-carbon technologies. However, we believe that China should further focus on the following aspects in advancing green and low-carbon technology innovations. First, similar to core technologies in other critical areas, China cannot expect merely to acquire or wait for the transfer of green and low-carbon core technologies. Instead, it should aim at the frontier of green and low-carbon technologies, improve its support system for green and low-carbon fundamental research, and scale up homegrown innovation to make up for existing weaknesses in its green and low-carbon technologies and reduce foreign dependence. Apart from greening existing

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

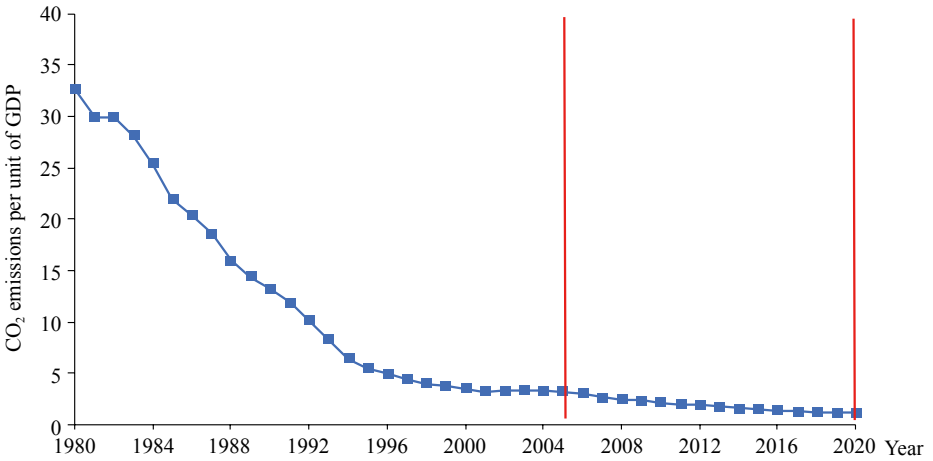

Figure 4: China's CO_2 Emissions per Unit of GDP from 1978 to 2020 (CO_2 Emissions Intensity)
Source: *China Statistical Yearbook*.

industries, green and low-carbon technological breakthroughs may engender a host of strategic green emerging industries as well.

Second, the market is the ultimate touchstone of the value of green and low-carbon technologies. We therefore believe that the market should play a decisive role in steering the development of green industries and picking technology pathways. Businesses should serve as the backbone of innovations under the market-based allocation of innovation resources. Finally, groundbreaking innovations can often be investment-intensive and risky with a length time until realized returns, and the same is true for research on green and low-carbon core technologies. However, in China currently, market entities and especially individual enterprises lack sufficient incentives for green and low-carbon innovations. As such, we believe that the government of China should step in to steer and support such innovations and establish administrative and operational systems for developing eco-friendly technologies.

4.2 Optimizing Resource Allocation to Facilitate China's Green and Low-Carbon Transition

Improving resource allocation is another key aspect of green and low-carbon economic transition along the dimension of "coordinated development." Green and low-carbon transition can be driven by either innovations that propel progress at the technology frontier or more efficient resource allocation without change to the technology frontier. The underlying logic is that macroeconomic efficiency is the weighted average of disparate efficiencies of various production entities, among which the reallocation of production factors from less efficient to more efficient ones will boost macroeconomic efficiency and environmental performance without incurring additional factor inputs or altering their technology frontier. Despite significant improvements in resource allocation efficiency since 1978, China's economic development remains fraught with distortions (Chen and Chen, 2017). In their influential study, Hsieh and Klenow (2009) found that resource allocation distortions had reduced China's economic efficiency by 30% to 50%. With greater economic efficiency, China can become better positioned to curb pollution and green its economy.

Among various dimensions of improving resource allocation, we focus on industrial and energy restructuring. Figure 5 shows the changing shares of China's primary, secondary, and tertiary industries from 1978 to 2020, which reflects the redistribution of economic resources among these sectors. Here we see that China's primary industry had been declining as a share of the economy, down from around 30% in 1978 to about 7% by 2020. During this time, the tertiary industry as a share of the economy had been rising steadily from 20% at the beginning of 1978 to 55% by 2020, and the secondary industry as a share

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

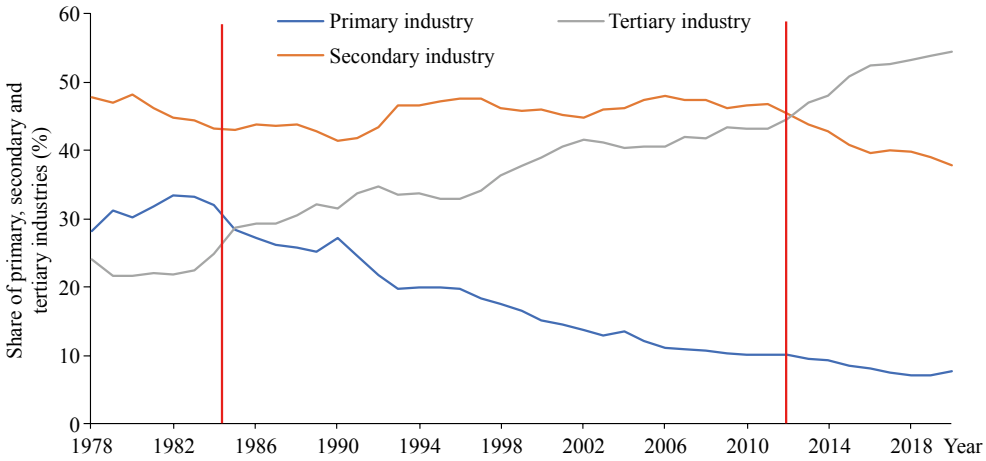

Figure 5: The Change in China's Industrial Structure from 1978 to 2020

Source: *China Statistical Yearbook*.

of the economy decreased slightly and stayed in the range of 40% to 50% with a significant downward trend since the 18th CPC National Congress in 2012. Compared with the tertiary industry, the secondary industry is much more energy intensive. In this sense, the falling share of the secondary industry and the rising share of the tertiary industry (resource reallocation from the secondary industry to the tertiary industry) help reduce emissions. Yet we still believe that China's green and low-carbon transition should be driven by endogenous industrial forces rather than inter-industry resource allocation. Our reasons are threefold. First, China's secondary industry as a share of the economy has dipped below 40%, leaving little room for further decrease. After all, the secondary industry, especially advanced manufacturing, serves as the backbone of the real economy. What matters more for the future is to allocate resources to more efficient economic entities in their respective industrial sectors by phasing out obsolete, nongreen industrial capacity.

In addition, energy mix improvement requires the reallocation of energy factors. Figure 6 shows the trend of China's energy consumption and energy mix from 1978 to 2020. Here we see that China's energy mix became transformed amid a spike in energy consumption. Coal as a share of total energy consumption fell by one fifth from about 70% in 1978 to 56% in 2020, and crude oil, natural gas, and other energy sources as a share of China's energy mix increased from about 30% in 1978 to 44% by 2020. Coal consumption as a major contributor to greenhouse gas and other pollutant emissions has decreased in China's energy mix in recent years, therefore reducing emissions. Less coal consumption means a greener economy, yet given its coal-dominated resource endowment, we feel it is unwise for China to jettison coal energy completely. From an energy security point of view, as the world's largest developing country with 1.4-billion population, China cannot and should not rely mainly on energy imports. This points directly to the importance of developing clean coal technology for greener and lower-carbon development. However, we believe that any potential future decrease in coal consumption should be a natural result of industrial upgrade. As the economy shifts from low-end to high-end manufacturing, for instance, the share of coal consumption may decrease with diminishing coal demand.

4.3 Creating a New Paradigm of Open and Shared Development

Openness and shared benefits are two important dimensions of China's development philosophy and are of great significance to its green and low-carbon economic transition. In the post-reform era since 1978 and especially since the 18th CPC National Congress in 2012, China has achieved many breakthroughs in green and low-carbon technologies. However, China still trails developed countries in

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

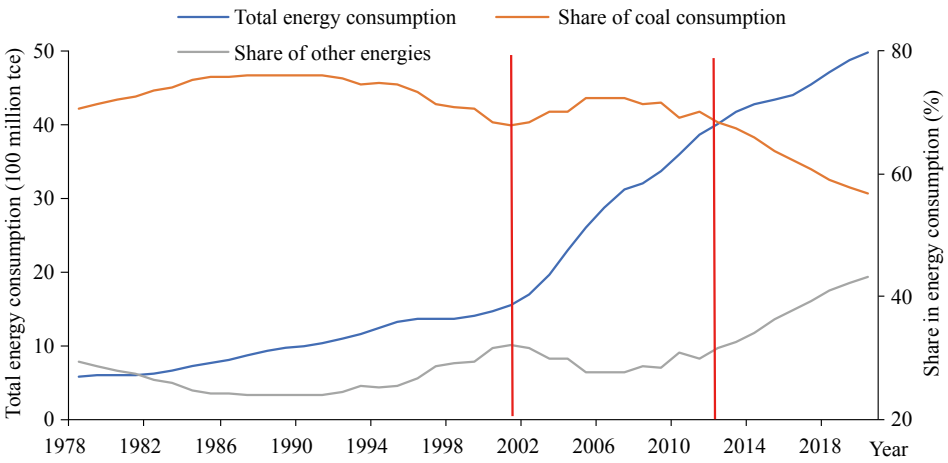

Figure 6: China's Energy Consumption and Mix in 1978-2020

Source: *China Statistical Yearbook*.

critical green and low-carbon frontier technologies. Along the dimension of openness, therefore, we believe that China should pursue a higher level of openness on the basis of "domestic circulation as the mainstay mutually reinforced with international circulation" and draw upon the technologies, concepts, and experiences of developed countries in the service of its own green and low-carbon innovations. Along the dimension of shared development, an important aspect of the green and low-carbon transition is to foster green and low-carbon lifestyles, oppose waste, and vigorously develop the circular economy.

References:

[1] Chang, Tom, Joshua Graff Zivin, Tal Gross, Matthew Neidell. 2016. "Particulate Pollution and The Productivity of Pear Packers." *American Economic Journal: Economic Policy*, 8(3): 141-69.

[2] Chen, Shiyi, Chen Dengke. 2017. "Dynamic Evolution of Resource of Allocation Efficiency in China: A New Approach of Incorporating Energy Factors." *Social Science in China*, 4:67-83+206-207.

[3] Chen, Shiyi, Chen Dengke. 2018. "Air Pollution, Government Regulations and High-quality Economic Development." *Economic Research Journal*, 53(02):20-34.

[4] Chen, Shiyi. 2009. "Energy Consumption, CO2 Emission and Sustainable Development in Chinese Industry." *Economic Research Journal*, 44(04):41-55.

[5] Copeland, Brian, Scott Taylor. 2004. "Trade, growth, and the environment." *Journal of Economic literature*, 42(1): 7-71.

[6] Fan, Gang, Su Ming, Cao Jing. 2010. "An Economic Analysis of Consumption and Carbon Emission Responsibility." *Economic Research Journal*, 45(01):4-14+64.

[7] Greenstone, Michael, Rema Hanna 2014. "Environmental Regulations, Air and Water Pollution, and Infant Mortality in India." *American Economic Review*, 104(10) : 3038-72.

[8] Hsieh, Chang-Tai, Peter J. Klenow 2009. "Misallocation and Manufacturing TFP in China and India." *The Quarterly Journal of Economics*, 124(4) : 1403-1448.

[9] Lin, Boqiang, Jiang Zhujun. 2009. "Prediction of Environmental Kuznets Curve of Carbon Dioxide in China and Analysis of Influencing Factors." *Journal of Management World*, 4:27-36.

[10] Pan, Jiahua, Zhuang Guiyang, Zheng Yan, Zhu Shouxian, Xie Qianyi. 2010. "Clarification of the Concept of Low-Carbon Economy and Analysis of its Core Elements." *International Economic Review*, 4:88-101+5.

[11] Yang, Kaizhong. 2021. "The Practice Mode of Xi Jinping's Eco-civilization Thought." *Urban and Environmental Studies*, 1:3-19.

[12] Zhang, Xin, Chen Xi, Zhang Xiaobo. 2018. "The Impact of Exposure to Air Pollution on Cognitive Performance." *Proceedings of the National Academy of Sciences*, 115(37) : 9193-9197.

(C)1994-2022 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net